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POWER AND THE ENGINEER

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY, 505 PEARL STREET, NEW YORK.

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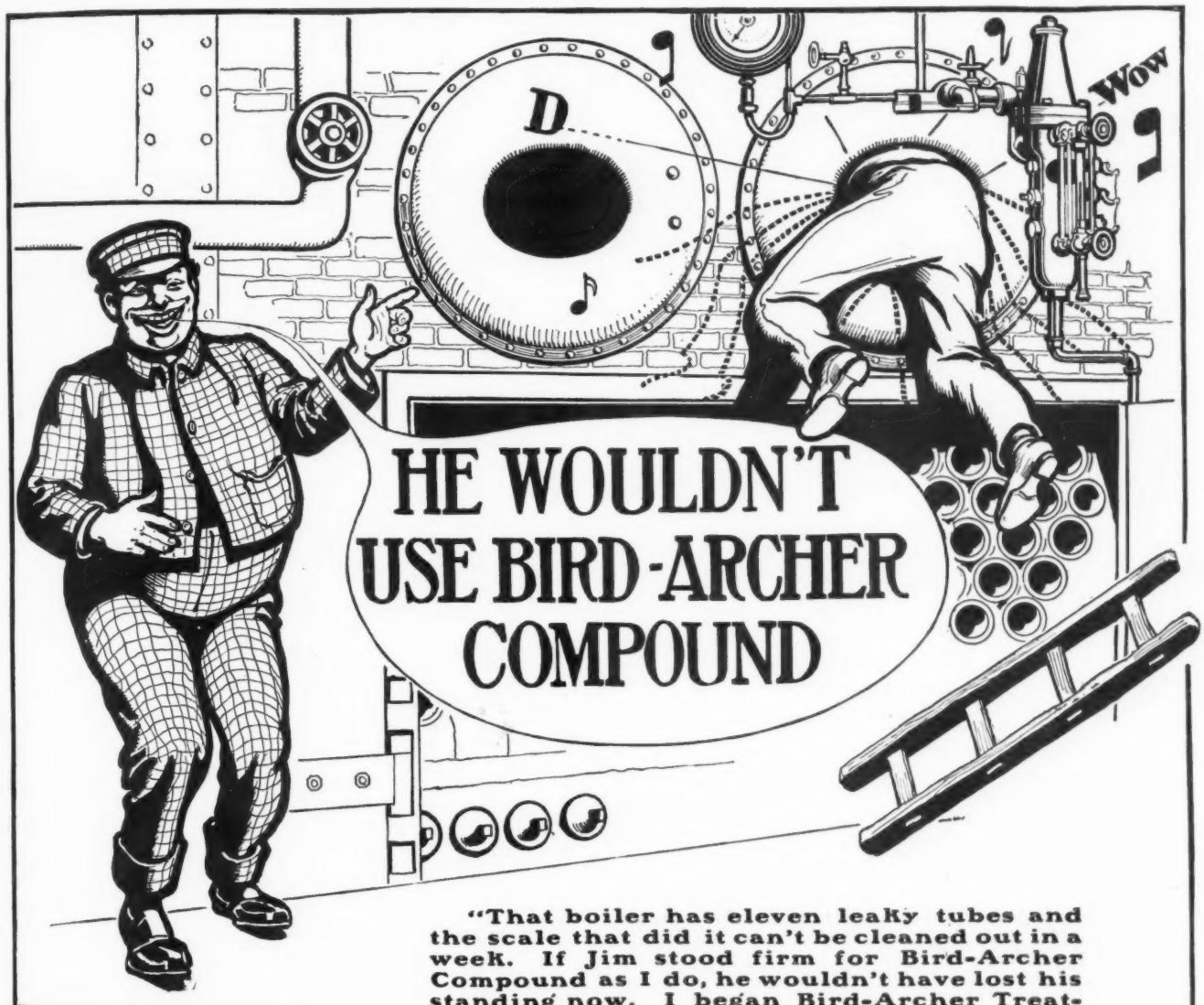

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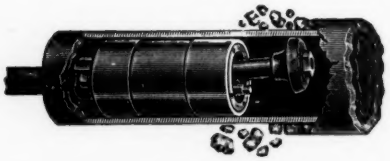

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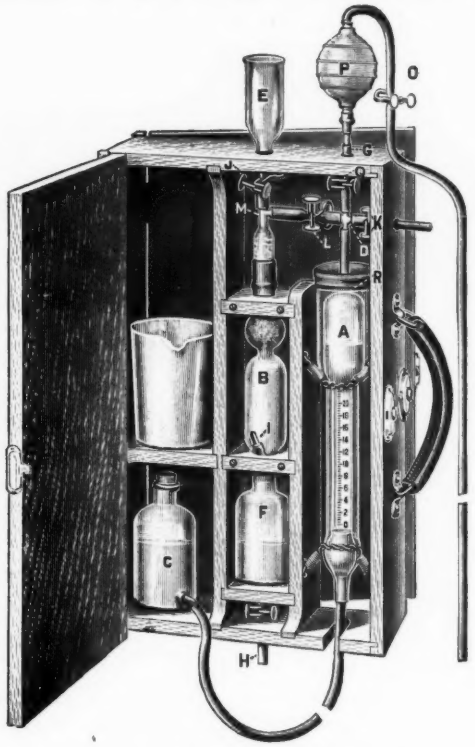

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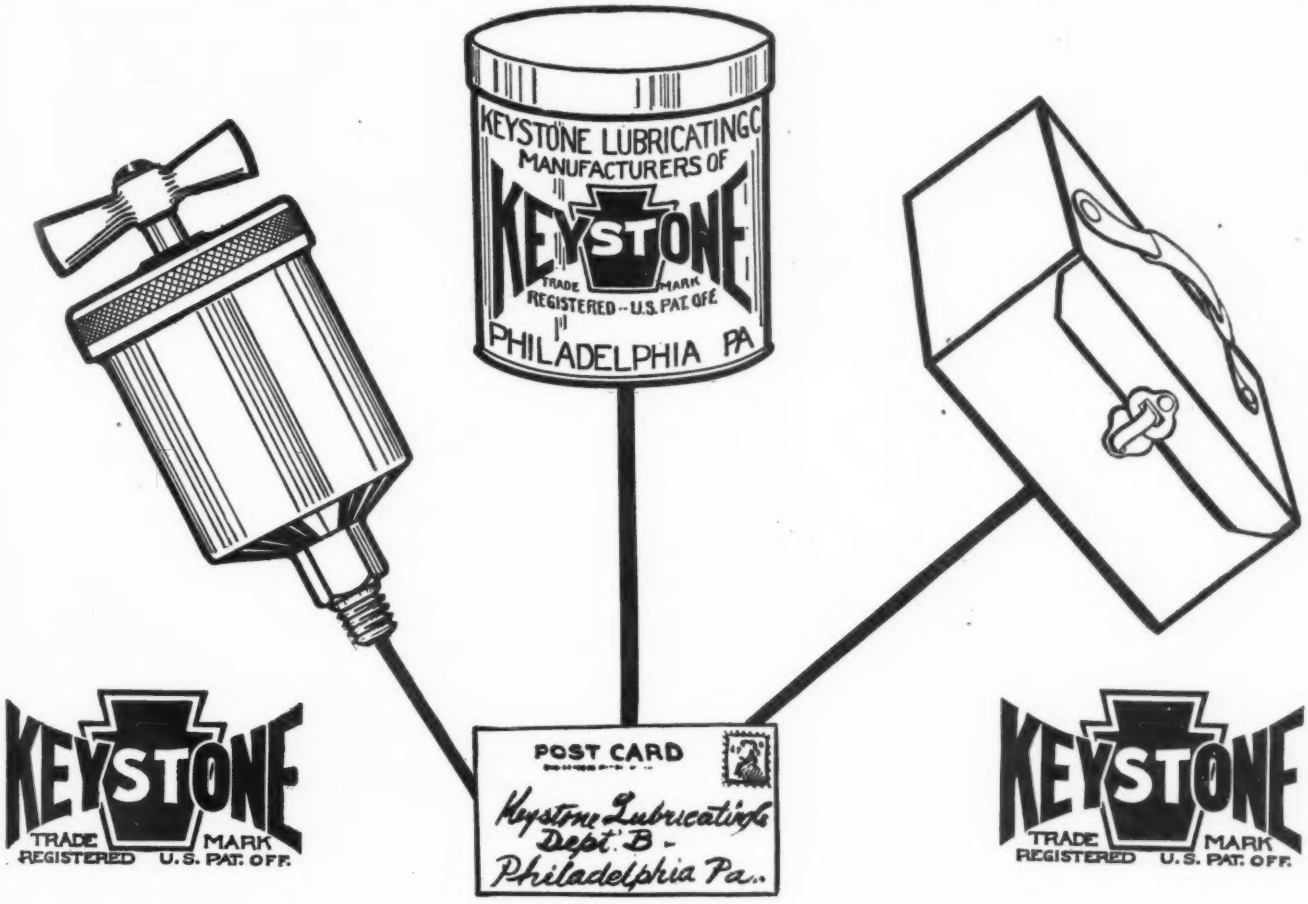

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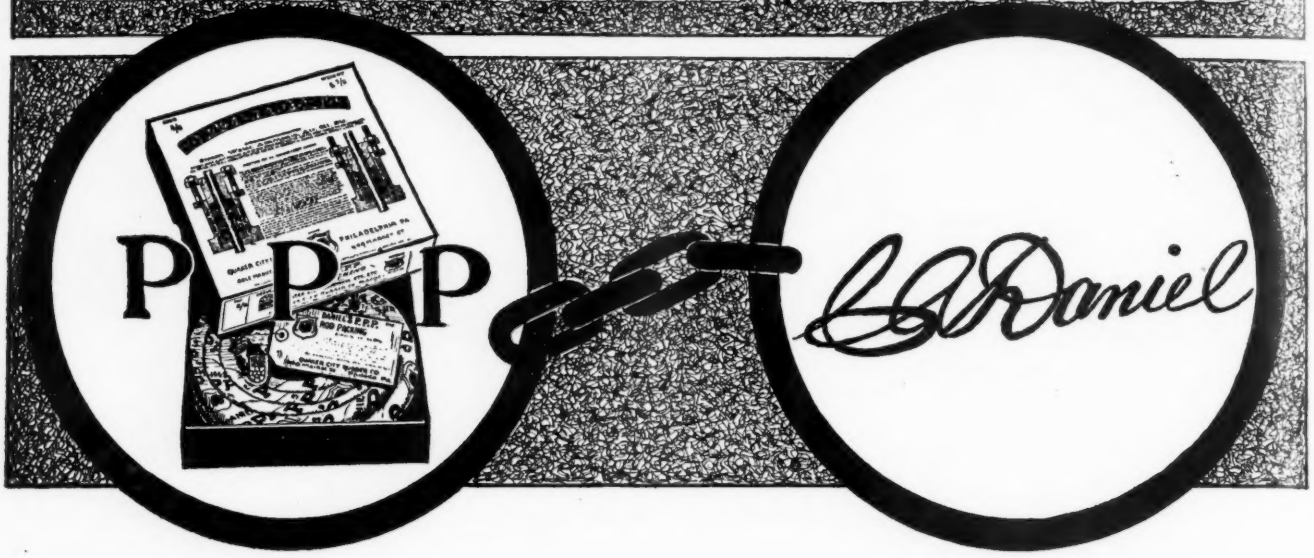

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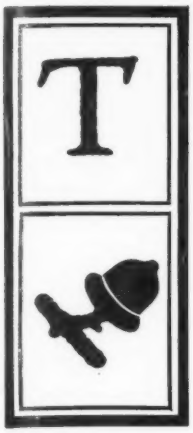

THERE is always one great pioneer and leader in the development of every important industry. Twenty years ago, the fact that great savings could be made in fuel consumption and that boilers and boiler tubes could be made to last much longer, but for the detrimental action of boiler feed waters, interested some young chemists in Chicago in the possibility of surmounting this difficulty by making careful analytical study of different classes of waters, and finding scientific reagents for the elements that produced the trouble.

Thus began the work of the DEARBORN COMPANY. That it has been successful is attested by the fact that thousands of steam plants use their products, prepared according to analysis of the waters, and find absolute relief from the troubles formerly experienced.

With its large corps of representatives, all of whom are *mechanical experts*, working in all sections of the country, backed by the scientific laboratory work done at Chicago, the Dearborn Company is able to give personal attention to every case, making careful study of the water and plant conditions and furnishing treatment that exactly meets requirements.

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Every engineer has experienced those annoying pipe line leaks, especially in screw joints where it is impossible to shut down in order to fix things up.

The day is over for worry, however; pipe line leaks can now be stopped without shutting down and with little trouble and at small expense. No elaborate apparatus is required, only two simple articles, SMOOTH-ON TAPE AND SMOOTH-ON ELASTIC CEMENT.

Here is the way to do it: Wrap the joint with one layer of SMOOTH-ON TAPE (this tape is especially prepared and is very adhesive), give the tape a thin coating of SMOOTH-ON ELASTIC CEMENT, then another wrap of tape and coating of cement. Repeat this operation several times and you will have a perfect and permanent joint. Simple, isn't it? But best of all the joint will never leak again.

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"The Smooth-On Compound and Elastic Cement came to hand all right and it gives me great pleasure to say that I was entirely successful in stopping the leak in my main line steam pipe mentioned in my first letter. Although it was a very bad one, being a screw thread joint, it is stopped as completely as though it had never been.

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SMOOTH-ON ELASTIC CEMENT can be used for a number of places where it is as useful and permanent as on screw joints, and may be applied as a paint, paste or putty.

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Don't forget we make SMOOTH-ON for all purposes for use around the power plant—there is hardly a repair where SMOOTH-ON cannot be used to advantage.

SMOOTH-ON GASKETS for flange joints are without an equal. Send for Smooth-On instruction book No. 5—it contains a lot of interesting points for any engineer.

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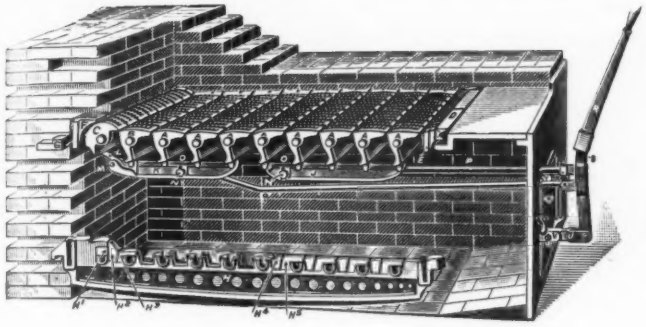

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Shaking Movement

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if you are using high priced coal in your plant—because if you will install McCLAVE GRATES, with ARGAND BLOWERS, you can use cheapest fuels with just as good results.

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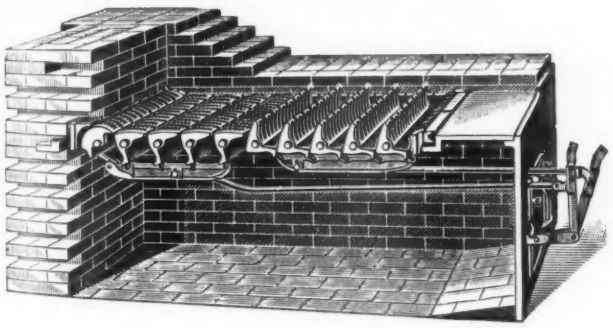
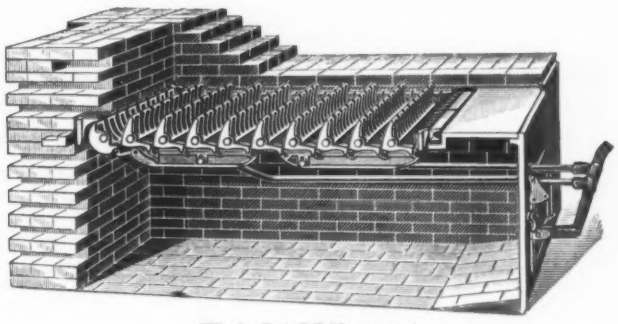
The full description of these money-saving grates is worth your immediate attention. Ask for Catalog "G."



Divided Cut-Off



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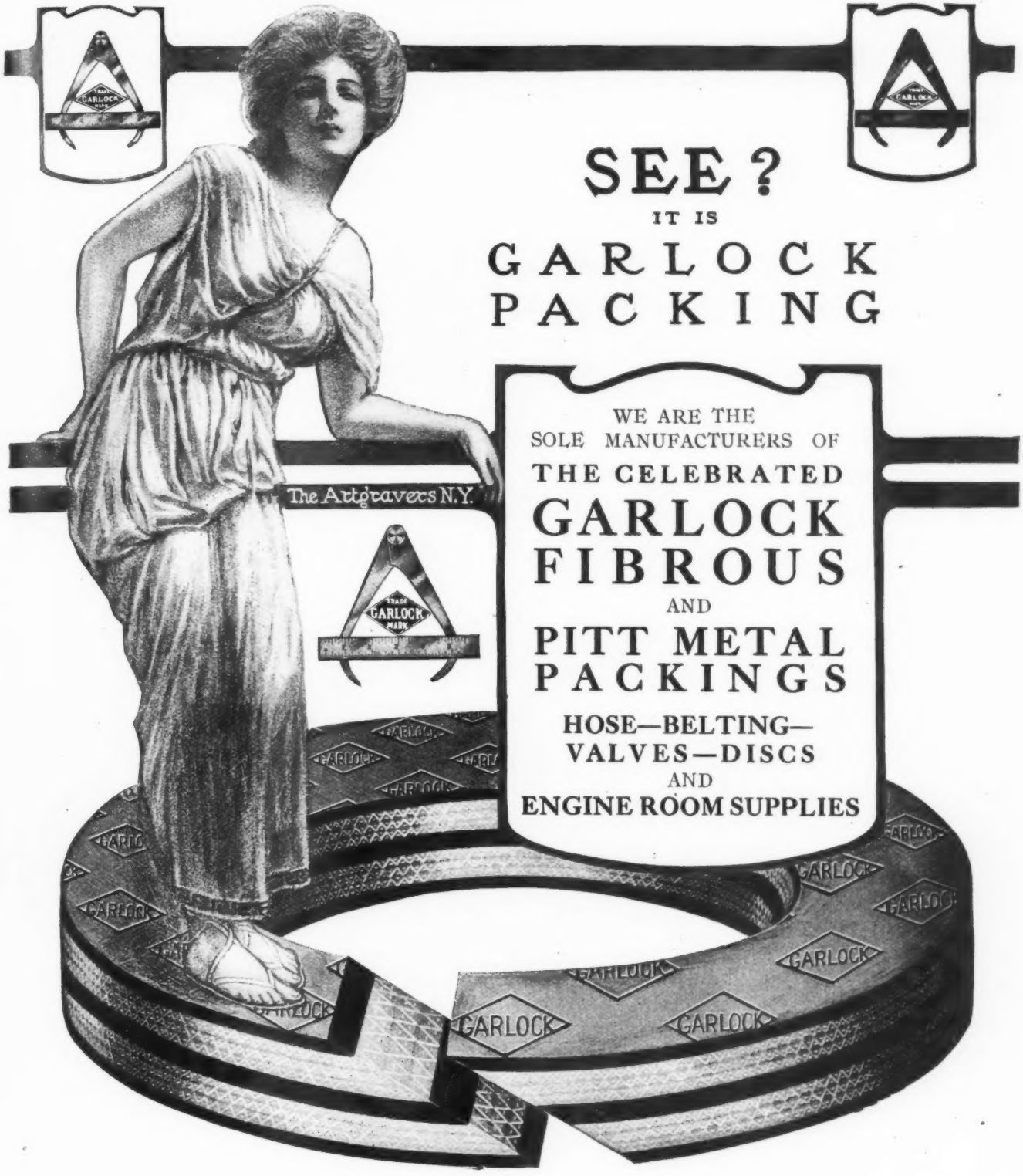

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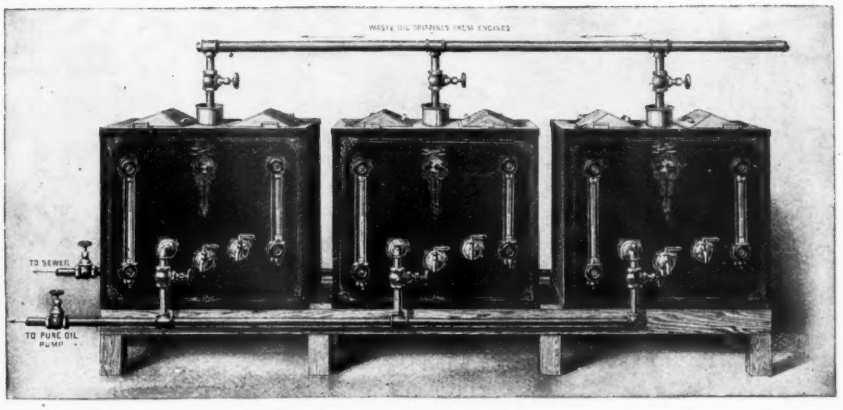

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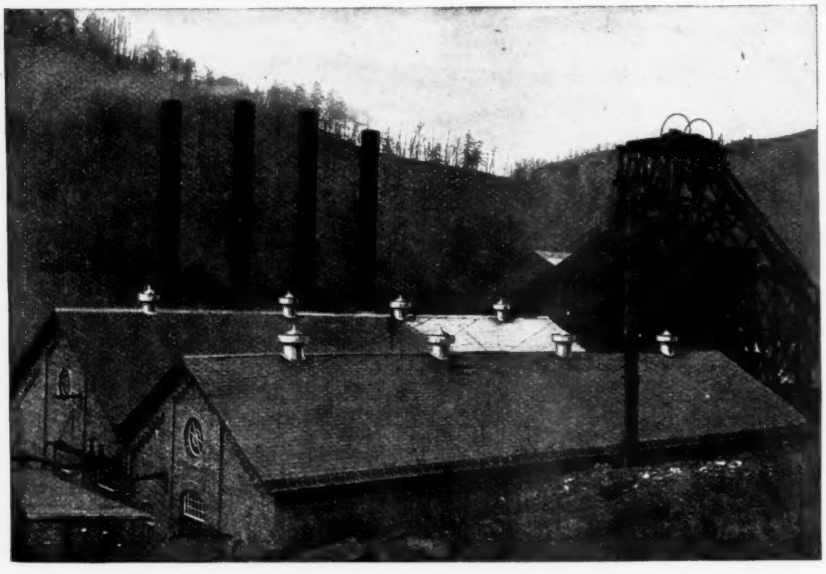
Largest Manufacturers of Oil Filters in the World.

A Few Burt Ventilator Users

The illustration herewith shows part of the plant of the Middle States Coal & Coke Co., Olmsted, W. Va., which uses 8 30-inch and 8 24-inch Burt Ventilators. (3rd order.)

These devices, with no expense of operation, automatically draw all impure air, smoke, steam and gas out of buildings. They are durable and reliable. A few other users are The Jones & Lamson Machine Co., 80 20-in.; The Yale & Towne Mfg. Co., 20 18-in.; The Florida East Coast Ry. Co., 48 24-in. U.S. Steel Corp., (22—7th order.) Practically every large order has come after a firm has given the "Burt" a thorough test.



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Power for a Large Manufacturing Works

Equipment of the Model Isolated Plant Recently Built by the Western Electric Company to Furnish Heat, Light and Power for Its Plant

BY OSBORN MONNETT

Early in the development of the electrical industry it was foreseen by the Western Electric Company that its plant on Clinton street, Chicago, would not be well adapted to the manufacture of the larger and heavier class of electrical apparatus, and that it would become necessary to secure a location where ample room could be provided not only for present needs, but for future growth, where buildings could be erected of suitable character equipped with heavy cranes for handling economically the largest apparatus, and having direct railroad facilities for receiving and shipping heavy machinery.

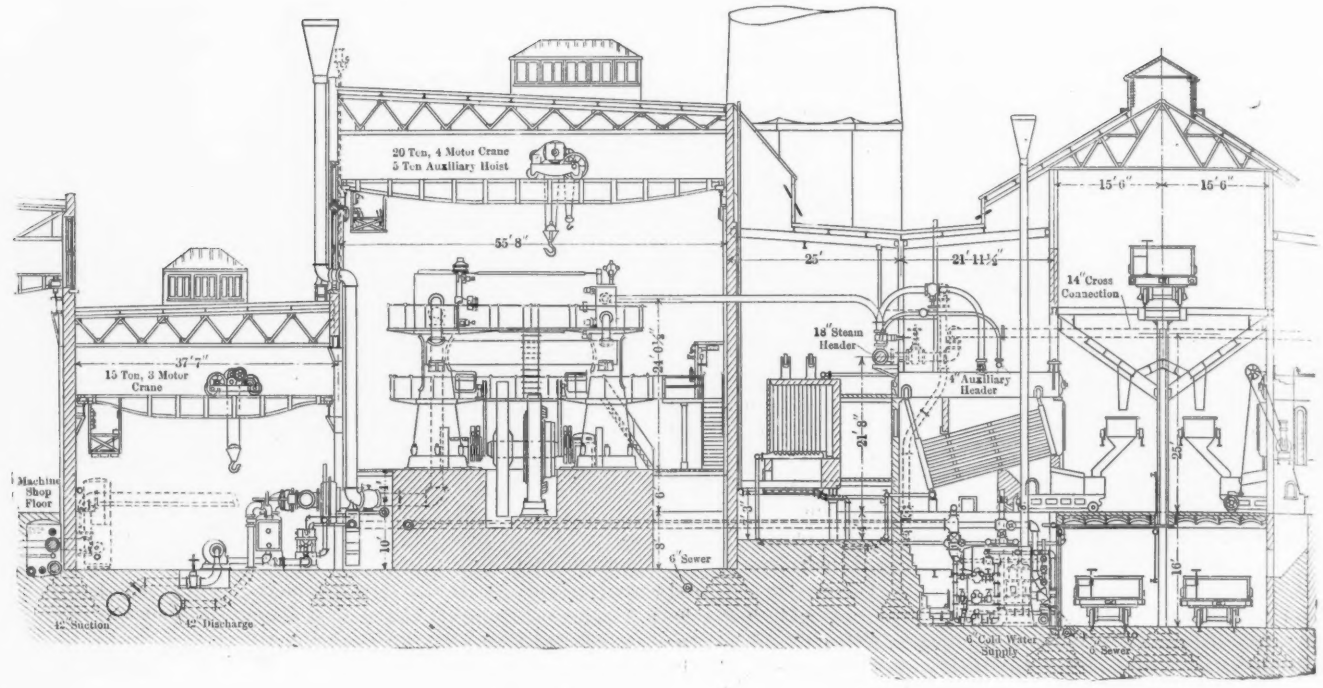
About five or six years ago a tract of 110 acres at the extreme west of the city of Chicago was purchased. Since that time more land has been acquired and extensions are now being built, which, together with the buildings already completed, constitute the Hawthorne works. Two railroad trunk lines, the Chicago, Burlington & Quincy and the Illinois Central, cross the plant and are provided with switch connections, while the Western Indiana Belt Line, Manufacturers' Junction Railroad and the Chicago Terminal Transfer Railroad Company give connection with all the other trunk lines entering Chicago.

The works consist at present of the following principal groups of buildings: The office, pattern shop, pattern storage, foundry, forge shop, machine shops, telephone supplies and enameled-wire building, and the cable and rubber-insulating plants, which latter are located east of the railway, dividing the plant into two parts. In addition to these buildings, there are a gas plant, water tower, two crematory buildings, freight house, round house for locomotives, and power plant. The latter, which can be seen from the main entrance to the works, as shown in Fig. 1, is located in the center of the group of buildings and contains every modern device connected with the economical generation of power, heating, ventilating and other services required in such a large industrial establishment. The power house is divided into engine and boiler rooms, the latter having a floor space of 20,700 square feet and provided with two chimneys, as indicated in Fig. 2, so that there is ample room for extension to the power-generating plant. Each chimney has an internal diameter of 12 feet, an external diameter at the base of 22 feet, and extends 250 feet above the boiler-room floor. Provision has been made for two batteries of boilers of eight each, a chimney dividing each battery into two sets of four.

FIG. 1. MAIN ENTRANCE TO HAWTHORNE WORKS

In the Boiler Room

In the handling of the coal at this plant, advantage has been taken of the existing conditions, which did not necessitate the use of machinery to put the coal into the hoppers. The main railroad tracks dividing the company's property are elevated considerably above the surrounding level, as will be seen at the extreme right in Fig. 3. This affords an easy method of switching the cars, by means of an elevated spur track, directly over the storage bins located above the boiler room. These bins are of 1000 tons capacity and are so designed that the coal may be dis-



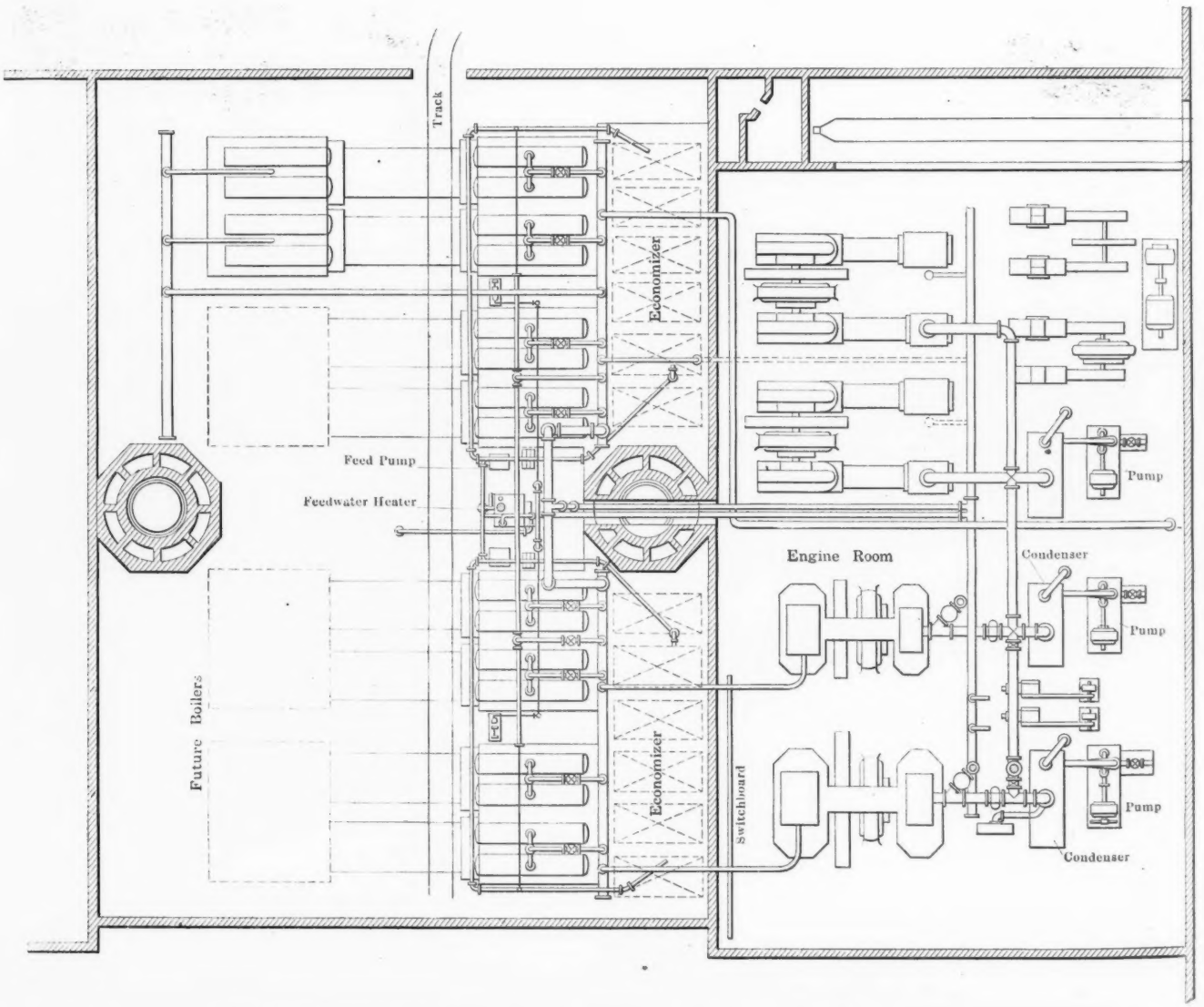


FIG. 2. ELEVATION AND GENERAL PLAN OF WESTERN ELECTRIC COMPANY'S POWER PLANT

FIG. 3. ELEVATED SPUR TRACK TO POWER HOUSE, WITH WATER TOWER IN BACKGROUND

charged through spouts into a hopper scale for each division of boilers.

At present there have been installed ten boilers, eight of which are of the Aultman & Taylor make, each having a heating surface of 5080 square feet, and designed to operate at 160 pounds pressure. The remaining two are of Babcock & Wilcox make and are of the same capacity. Each boiler setting is so arranged that superheaters may be installed at a later date, should it be thought advisable. Pressed brick is used in the settings and great care has been exercised in making the installation a model one in every respect. Reliance water columns, Crosby steam gages and Consolidated pop valves are used. Fig. 4 shows a battery of the Aultman & Taylor boilers and the Mansfield chain-grate stokers with which they are equipped. The two new Babcock & Wilcox boilers lately installed have standard Babcock & Wilcox chain-grate stokers. Each of the batteries of four boilers is provided with a Green fuel economizer of 68 sections, 12 tubes wide. No economizer has been installed for the two Babcock & Wilcox boilers, but space has been left so that when the boiler equipment is completed it will be possible to install them.

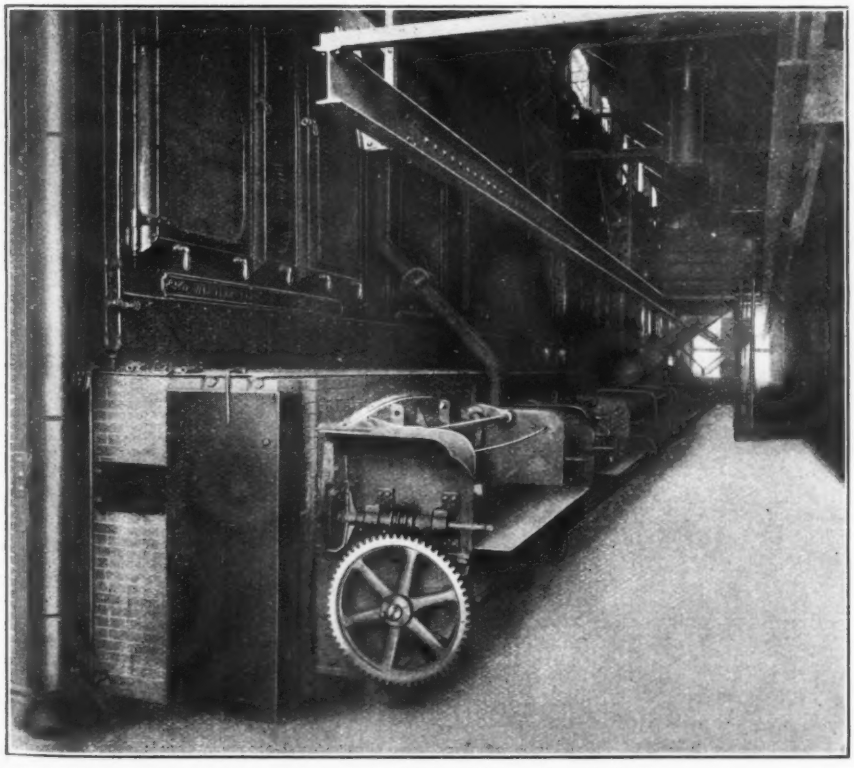


FIG. 4. BOILER ROOM OF THE HAWTHORNE WORKS

Coal from the hoppers descends into a traveling scale conveyer, which is shown in Fig. 5. This scale is mounted on a track and may deliver to any one of the stoker hoppers. It is of simple construction, the arrangement of the levers being such as to impose but little work on the weighing arm, thus tending to permanent accuracy. The use of such a device makes the matter of keeping coal records simple and convenient. Ashes are discharged at the end of each chain-grate stoker into a bin of two tons capacity, located below each boiler. From these bins the ashes are delivered into gondola cars carried on a depressed railroad track extending in front of the boiler foundations, thus making the handling of the ashes as simple a problem as the delivery of coal, no apparatus of a mechanical nature being required.

Feed water is taken from the city mains and delivered to an 8000-horsepower Cochrane open feed-water heater, which is situated in a pit between the two batteries of boilers. Three feed pumps, two of the Worthington vertical Admiralty type, each 14x10x15 inches, and one 12x20x12x18-inch Platt Iron Works pot-valve pump, are installed. The feed piping is entirely in duplicate, and of the most substantial character. An average temperature of 210 degrees is maintained in the heater, and the water enters the boilers at approximately 270 degrees, the flue gases before entering the economizers averaging 475 degrees. Located in the feed line is a Venturi feed-water meter. This consists of a separate casting introduced into the feed pipe and containing a restricted annular opening through which the feed water passes. The difference in pressure between the entrance and outlet of the casting is measured by a manometer consisting essentially of a U-tube partly filled with mercury, one side of which connects with the up-stream pressure chamber, while the other side is connected to the other pressure chamber of the meter tube, as indicated in Fig. 6.

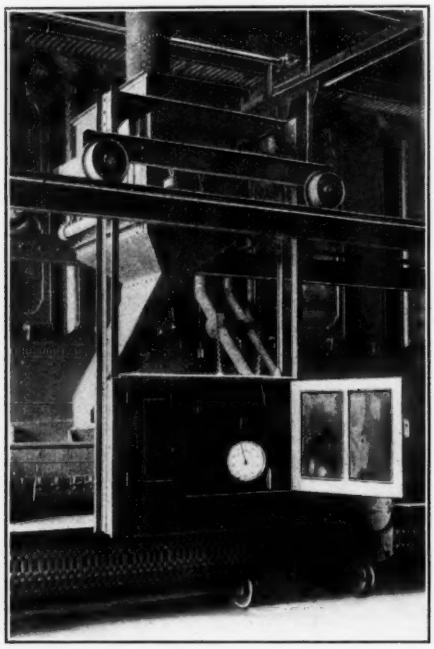


FIG. 5. WEIGHING HOPPER AND CONVEYER

Since the difference between these two pressures is approximately proportional to the square of the velocity of the water, the rate of flow is easily determined by observing the difference between the mercury levels, the scale of the instrument being calibrated, in this case, to read in gallons per 24 hours.

The Engines

The engine room and condenser pit take up the remaining space in the power house. Together they have a floor space of some 16,000 square feet, the engine room proper being elevated above the condenser room and served with a 25-ton Niles crane. As characteristic of all

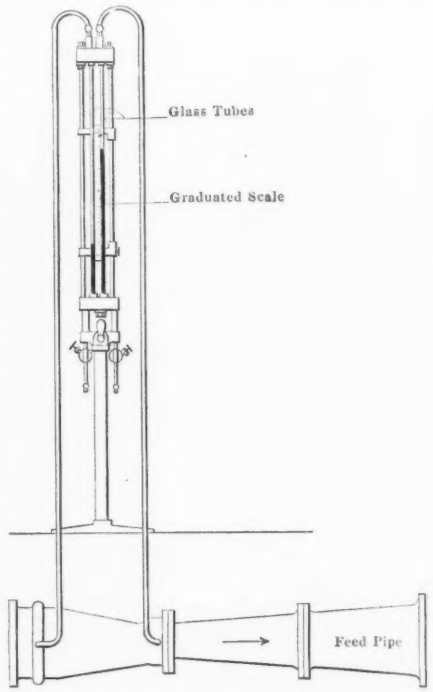


FIG. 6. VENTURI FEED-WATER METER

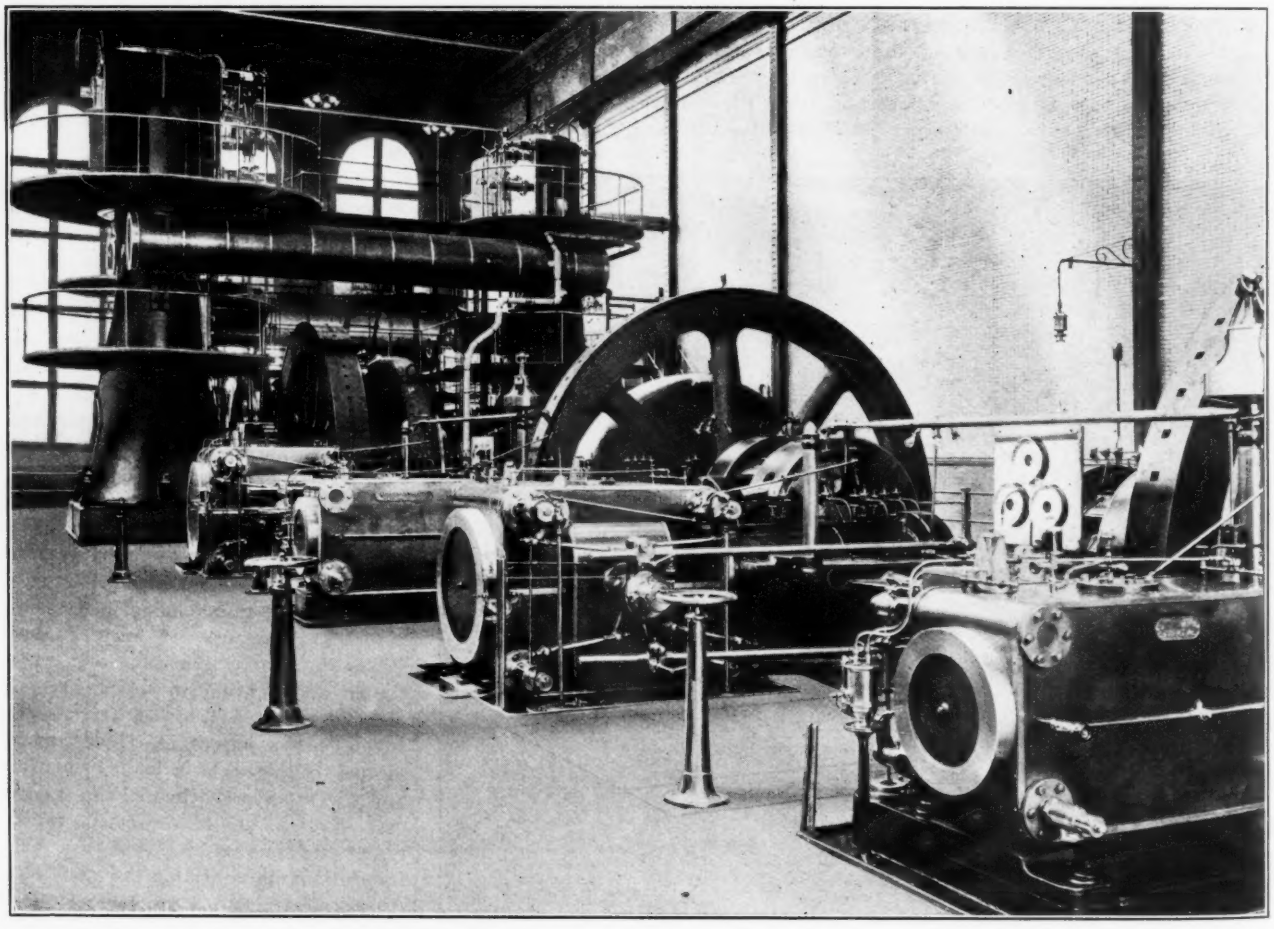


FIG. 7. A VIEW IN THE ENGINE ROOM AT THE HAWTHORNE PLANT OF THE WESTERN ELECTRIC COMPANY

other parts of the plant, no expense has been spared in finishing the engine room. The walls are of pressed brick with colored wainscoting, the floors are of red tile, and in keeping with the handsome appearance of the room, the finish of the engines is exceptionally fine.

Two horizontal cross-compound generating units and two vertical cross-compound machines are installed. The horizontal units are Filer & Stowell engines, connected to 300-kilowatt and 500-kilowatt generators, respectively. These engines have cylinders 16x32x42 inches and 20x40x42, and run at 100 revolutions per minute. Of the two vertical units, one is a 1000-kilowatt Filer & Stowell, with cylinders 30x60x48 inches and running at 80 revolutions per minute; the other is a Rice & Sargent of 1200 kilowatts capacity, running at 100 revolutions per minute, and with cylinders 32x62x48 inches. The Filer & Stowell engines are of the "1900" heavy-duty rolling-mill type. Double-ported valves are used, with separate eccentrics and wristplates for steam and exhaust, designed for a range of cutoff under the control of the governor from 0 to ¾ stroke.

The Rice & Sargent engine, as shown in Fig. 8, obtains its valve motion without the use of wristplates, the valves being directly connected to rods leading to intermediate rockers to which the eccentric rods are connected. The engine is equipped with an inclosed governor, which combines both the centrifugal and inertia principles and acts on the tripping mechanism in a direct and positive manner. The main journals of the engine are water-jacketed, as shown in the illustration, and the overflow is in plain sight of the operator.

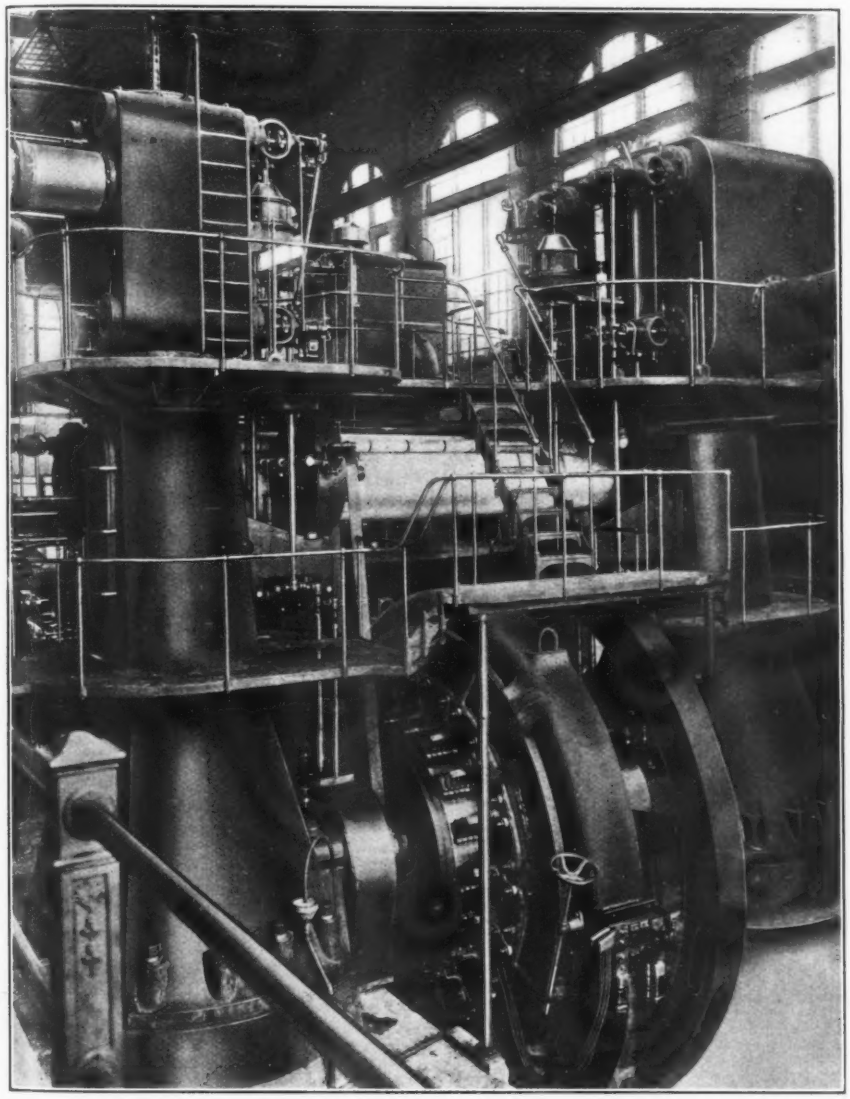


FIG. 8. RICE & SARGENT VERTICAL ENGINE

The vertical units receive their steam from overhead connections from the main header, the steam first passing through Cochrane separators. Engine stops are provided on the engines, both Locke and Monarch makes being represented. On a gage board in the engine room are Crosby recording steam gages, compressed-air gages, and gages registering the pressure on the fire system; also a recording Bristol voltmeter.

For lubrication, the Siegrist automatic oiling system is installed, carrying engine oil at a pressure of 75 pounds per square inch. This oil is piped to all bearings, and the pressure is maintained by small duplex pumps in duplicate, there being an electric alarm in the engine room to notify the attendants in case the pressure should fail. Two grades of valve oil are used; one for the high-pressure cylinders and one for the low. This oil is piped to individual force-feed oil pumps on the respective engine cylinders. The two horizontal units are equipped with Phoenix force-feed pumps and the vertical units have pumps made by the Sight Feed Oil Pump Company. In the vertical engines the valve oil is introduced at each end of each valve, making eight points in all where the oil enters each cylinder. Engine oil is collected in White Star filters, where it is purified before using again in the engines.

The Generators and Switchboard

All of the generators are of the Western Electric Company's L design, and operate in parallel at 230 volts; the frames are divided vertically, which permits drawing the yoke apart horizontally, allowing access to the armature for inspection. The pole pieces are laminated, the frame being cast around the assembled poles. An interesting constructional detail, in connection with the fields of these machines, is the fact that they are assembled in a heavy cast-iron clamp which is placed in the mold and around which the cast-iron field is run. This arrangement takes up the shrinkage strains in the yoke and insures against distortion of the pole-pieces. Armatures of these machines are of the iron-clad type, provided with radial ventilating spaces which connect with horizontal openings in the armature centers, allowing thorough ventilation. Commutators are ventilated by means of horizontal air ducts.

The main switchboard, which is shown in Fig. 9, is located on a gallery in the engine room and consists of eighteen 30x78-inch white marble panels. Connections are arranged so that the two smaller units may be operated in series to give 550 volts for testing purposes, the shunt-field coils of these two generators being of sufficient capacity to permit of an increase in the terminal voltage of the machines. Four generator panels are provided, each of which carries an ammeter, a circuit breaker, a field switch and rheostat in addition to two single-pole main switches. Adjoining the generator panels is a station panel which is equipped with an ammeter, a recording voltmeter and recording wattmeter by which the entire electrical output of the power house may be measured. Each feeder panel takes care of two circuits, each circuit having

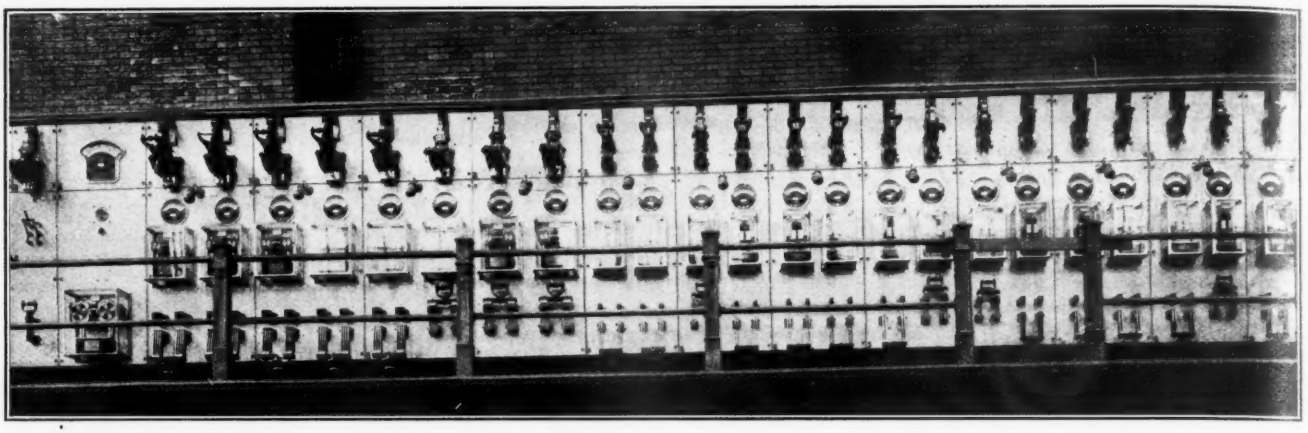


FIG. 9. SWITCHBOARD IN THE WESTERN ELECTRIC COMPANY'S HAWTHORNE PLANT

its circuit breaker, ammeter, wattmeter and main switch. By means of this arrangement it is a simple matter to keep track of the power used by any department. The switchboard is of Western Electric construction throughout.

Condensing Equipment

All of the engines operate surface-condensing, circulating water being obtained from a cooling pond or reservoir of four million gallons capacity, located in the yard. The two horizontal units exhaust into a Wheeler Condenser and Engineering Company's condenser, containing 3200 square feet of cooling surface and equipped with a Blake duplex single-acting air pump with cylinders 7½x16x10 inches. For handling the cooling water in this condenser, there is a 10-inch motor-driven centrifugal pump, direct-connected to a Western Electric direct-current motor of 37 horsepower capacity. This circulating outfit, in common with the rest, has only to overcome the friction of the pipes, as the condensers are located below the level of the water in the reservoir and the suction and discharge pipes are both submerged. Before passing to the condenser the exhaust is led through a Cochrane oil separator, and in the operation of the plant no trouble has thus far been experienced from oil in the boilers.

A similar condenser installation takes care of the vertical Filer & Stowell engine and for the Rice & Sargent engine a condenser of the same make, but provided with 4500 square feet of cooling surface, is installed. The air pump for this condenser is a 9x20x12-inch unit, and the motor-driven circulating pump has a 12-inch discharge, the motor having a rating of 45 horsepower. The average vacuum obtained with this condenser arrangement is about 25 inches. At the time of the

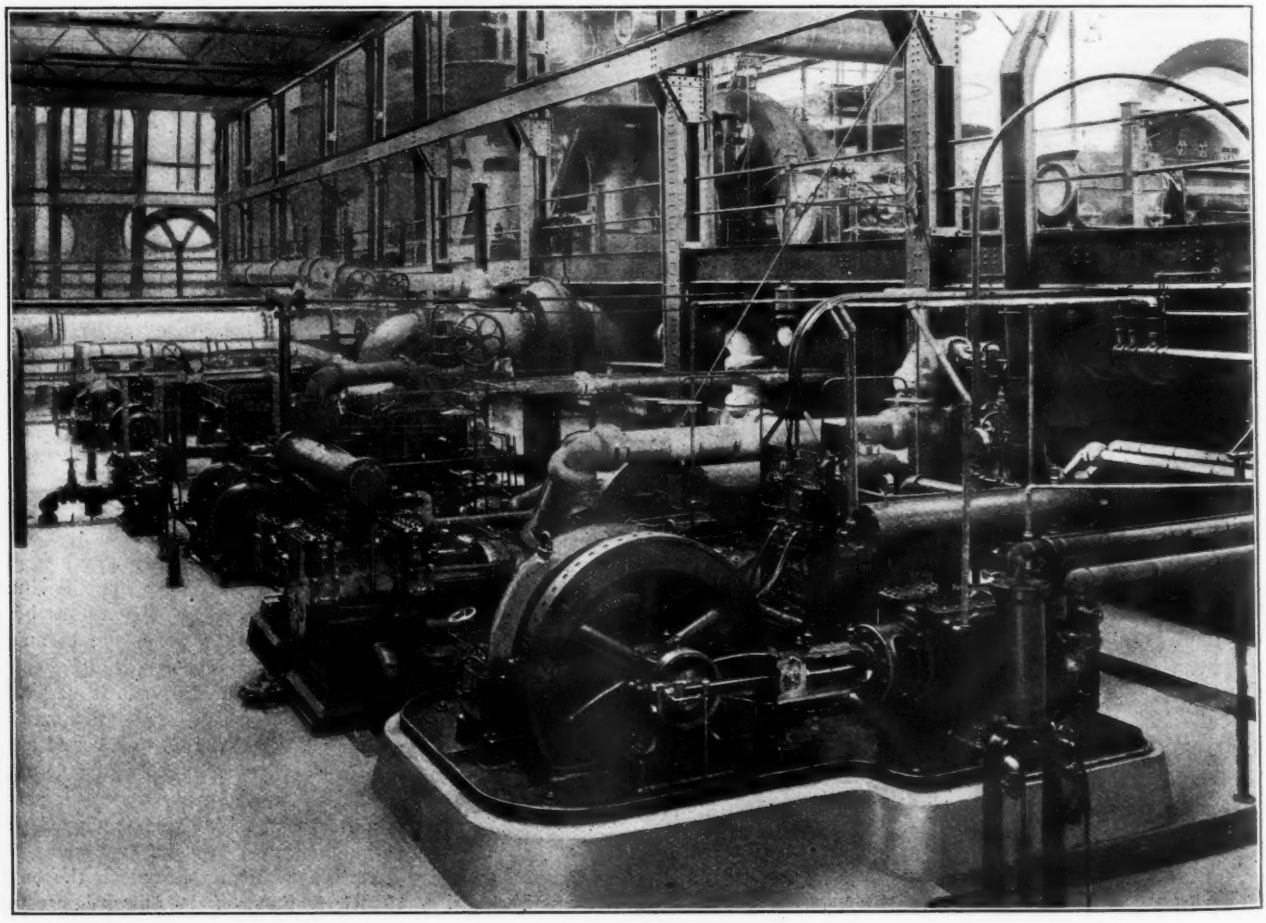


FIG. 10. CONDENSERS AND AUXILIARY MACHINERY IN THE WESTERN ELECTRIC COMPANY'S PLANT

writer's visit to the plant the temperature was 90 degrees in the shade, and 25¼ inches of vacuum was being carried without trouble on the 1200-kilowatt unit, which was running on its usual rated load. The management, however, is considering the proposition of installing a spray-cooling system in the reservoir. Chapman valves are used in the condenser installation.

Among the auxiliary machinery installed in the condenser room are two air compressors, shown in the foreground in Fig. 10. The first is an Ingersoll-Rand four-stage high-pressure machine, which is directly driven by a Western Electric motor. This machine delivers air at a pressure of 1000 pounds per square inch for the compressed-air locomotives used in the lumber yards of the plant. Alongside of this compressor is a Laidlaw-Dunn-Gordon Company's machine, with mechanically actuated air valves, and cylinders 12x19x20x12x18 inches. This furnishes air in the shops at 90 pounds pressure for manufacturing purposes. Other equipment installed in the farther end of the condenser room consists of hydraulic pumps for elevators, of which there are eight situated at various points in the plant. The main pump is of the motor-driven triplex horizontal single-acting type, driven by a Western Electric motor of 40 horsepower and maintaining 880 pounds on the hydraulic system. The motor is controlled by an Otis magnetic regulator, and the pump has cylinders 3¼ inches in diameter by 6-inch stroke. To supplement this pump there is a steam-driven duplex plunger pump, with cylinders 10x3x10 inches.

Heating

Heating is accomplished by both the direct and indirect systems. The former is the Webster vacuum return system, the two vacuum pumps being of the Knowles type, 8x14x16 inches. Connections are arranged so that the main engines can operate noncondensing, supplying steam to the heating system and also so that live steam can be turned in when desired. The other heating system installed is of the Evans-Almiral hot-water type. The water is heated in a vertical cylindrical heater standing on the condenser floor. This heater receives exhaust steam from the engines in its discharge to the condensers and does not interfere with the operation of the engines in any way. Live steam is piped to a second heater in case of necessity. The hot water from the heater is circulated by a Lawrence centrifugal pump attached to a Western Electric 50-horsepower motor, and is supplemented by one steam-driven De Laval centrifugal pump, attached to a De Laval steam turbine, the unit running at 3500 revolutions, and having a capacity of 1400 gallons per minute.

Fire Protection

Although city water is used for boiler feeding, comparatively little of it is needed, as the water from the condenser hot wells is discharged into the large Cochrane heater. In practice it is found that about 10 per cent. of the total feed water is make-up. For cooling purposes artesian water alone is used. This is supplied by two driven wells, both 1600 feet deep and 5 inches in diameter at the bottom. This water, which is not suitable for feed purposes, is discharged directly into the four-million gallon reservoir, and in addition to being used for cooling water, is also available for fire protection. A complete sprinkler and fire-hydrant system is installed at the plant, and is connected with tanks located in the water tower shown in Fig. 3. These tanks have an aggregate capacity of 213,000 gallons, the bottom of the lowest tank being 30 feet above the highest sprinkler outlet. In the basement of the tower are two 1500-gallon Fairbanks Underwriters' fire pumps ready for instant use, and when the tank supply is exhausted, the reservoir holds sufficient water to supply the fire pumps continuously for many hours.

Storing Coal under Water

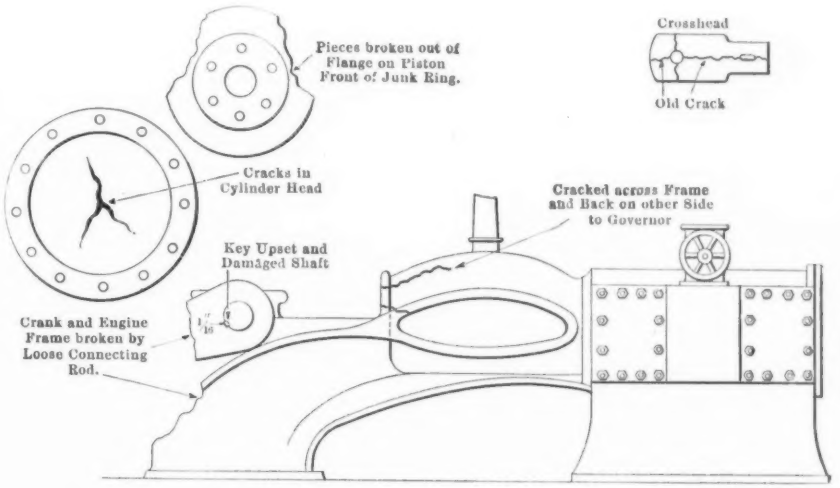
An interesting series of experiments has been conducted at this plant on the storing of coal under water. Two storage bins, one of 4000 and the other of 10,000 tons capacity have been constructed, both located below the normal ground level, so that coal may be dumped from cars and the bins filled with water. After six months' to a year's storage the system has been found to operate very successfully and has reduced the loss by storing to practically nothing. It is calculated that sufficient storage capacity of this kind has been provided to supply the plant under normal winter conditions for four months.

O. C. Spurling is superintendent of service and maintenance, and C. Bollinger is chief engineer.

An Engine Wreck at Dayton

By L. L. Swain

On the morning of August 31, 1908, the engine at Pinneo & Daniels Steel Works, at Dayton, Ohio, was badly wrecked. It was an old Wright four valve engine, made at Newburgh, N. Y. The dimensions of the cylinder were 20x42 inches, the speed was 75 revolutions per minute, and the steam pressure 110 pounds per square inch. The piston rod was keyed to the crosshead, which during the accident was broken in two halves, due to an old crack in the metal running parallel with the piston-rod key slot. The engine ran under, and on this day was started at the usual time. It was running nicely when, without notice, the crosshead split in two and the key forced the two halves apart. This split the crank end of the top crosshead guide loose from the frame, and the piston shot to the head end of the cylinder. The momentum of the flywheel carried the crank over and the end of the connecting rod, which had broken loose from the crosshead, came against the broken crosshead in the guide and bent the rod a little, besides breaking the crank off about the middle of the web. The cylinder head was cracked to some extent, and when it was removed, the piston, which had a junk ring with two snap packing rings and a follower plate, was removed in about 80 pieces. The follower-plate bolts were all in place, although the follower plate was broken away from the bolts, with the exception of one piece 2½ inches in diameter, which was still secured by one of the bolts. The junk ring and snap packing rings were broken in pieces ranging from 1 inch to 1 foot in length. The connecting rod, taking a part of the crank and also a piece of the bedplate forming the oil receptacle for the bearing with it, was thrown some 4 feet in front of the engine.


Pieces broken out of Flange on Piston Front of Junk Ring.
Crosshead
Old Crack
Cracks in Cylinder Head
Cracked across Frame and Back on other Side to Governor
Key Upset and Damaged Shaft
Crank and Engine Frame broken by Loose Connecting Rod.

SOME OF THE BROKEN PARTS OF WRECKED ENGINE

Determining the Capacity of a Power Pump

A Practical Method of Calculating Displacement and Delivery, Pointing Out, also, the Most Common Sources of Loss in Pump Operation

BY W. H. WAKEMAN

Fig. 1 illustrates one side of a duplex power pump used to draw water from driven wells and deliver it into an elevated tank. It is of the center, outside-packed plunger type and is, therefore, fitted with what are practically two single-acting plungers for the part shown, which is duplicated when the whole pump is taken into consideration. Each plunger is 12 inches in diameter and the stroke is also 12 inches, constituting what is commonly called a "12-square pump," although the term is not strictly correct. The plunger rods are 2 inches in diameter, and as they operate through stuffing boxes in the usual way, it is proper to call them piston rods if they are fitted to a piston pump, or form part of a steam engine.

The pulley, which contains six spokes, is keyed to a shaft that carries a pinion on the other end of it, and this meshes into the large gear wheel shown, giving it a speed of 22 revolutions per minute; therefore, during the above-mentioned time the complete pump makes 44 strokes with plungers that are driven by rods 2 inches in diameter, and 44 with other plungers that are only extensions of the former; consequently, the rods are not a factor in the calculation when the latter are considered. For convenience, only the parts shown in the illustration are taken, and the results secured are multiplied by 2 for the whole pump.

To Determine the Displacement

The displacement of a pump plunger is the space that is filled with water at one stroke and discharged during the next under absolutely perfect conditions. The displacement of what may properly be called the crank end of this pump may be determined by the following formula, by those who prefer what is sometimes called a scientific calculation:

$$\frac{3.1416\ D^2\ L\ N}{4 \times 231} - \frac{3.1416\ P^2\ L\ N}{4 \times 231} = G.$$

where

D = Diameter of plunger in inches,
L = Stroke in inches,
N = Number of strokes during which water is discharged,
P = Diameter of rod in inches,
G = Gallons per minute.

Applying it to this case gives the following result:

$$\frac{3.1416 \times 12^2 \times 12 \times 22}{4 \times 231} - \frac{3.1416 \times 2^2 \times 12 \times 22}{4 \times 231} =$$

$$129.2544 - 3.5904 = 125.664$$

gallons per minute for the crank end (in accordance with steam-engine practice), as it discharges water once for each revolution of the disk crank which drives it. This point is mentioned because it is not always understood when considering this kind of a pump.

The head end will next be considered and in this case only the first part of the formula applies, because there is no rod to occupy space that would otherwise be filled with water. This shows that it delivers 129.2544 gallons per minute, and by adding the displacement of the crank and the head ends together it is plain that the part shown ought to deliver 254.9184 gallons per minute. When this is multiplied by 2 it shows that the displacement of both sides working together is 509.83 gallons per minute.

A More Practical Method

While the above method is correct, it does not appeal to the working engineer because it does not explain itself as the process proceeds, hence the following rule is submitted for the benefit of those who prefer it:

Rule—*Multiply the effective area in square inches by the stroke in inches and by the number of strokes per minute. Divide by 231 and the quotient is the number of gallons delivered per minute.*

The effective area of a water plunger or a piston is the total area, minus the space occupied by the rod. If there is no rod to be taken into consideration, use the total area.

In this case the diameter of the plunger is 12 inches, and by consulting a table of the areas of circles, the corresponding area is found to be 113.0976 square inches, and the same table shows that the area of a 2-inch circle is 3.1416 square inches, thus giving direct results without calculation. As one of these tables is found in almost every engineers' pocketbook, also in many catalogs of machinery and supplies, etc., they should be used freely.

By subtracting the latter from the

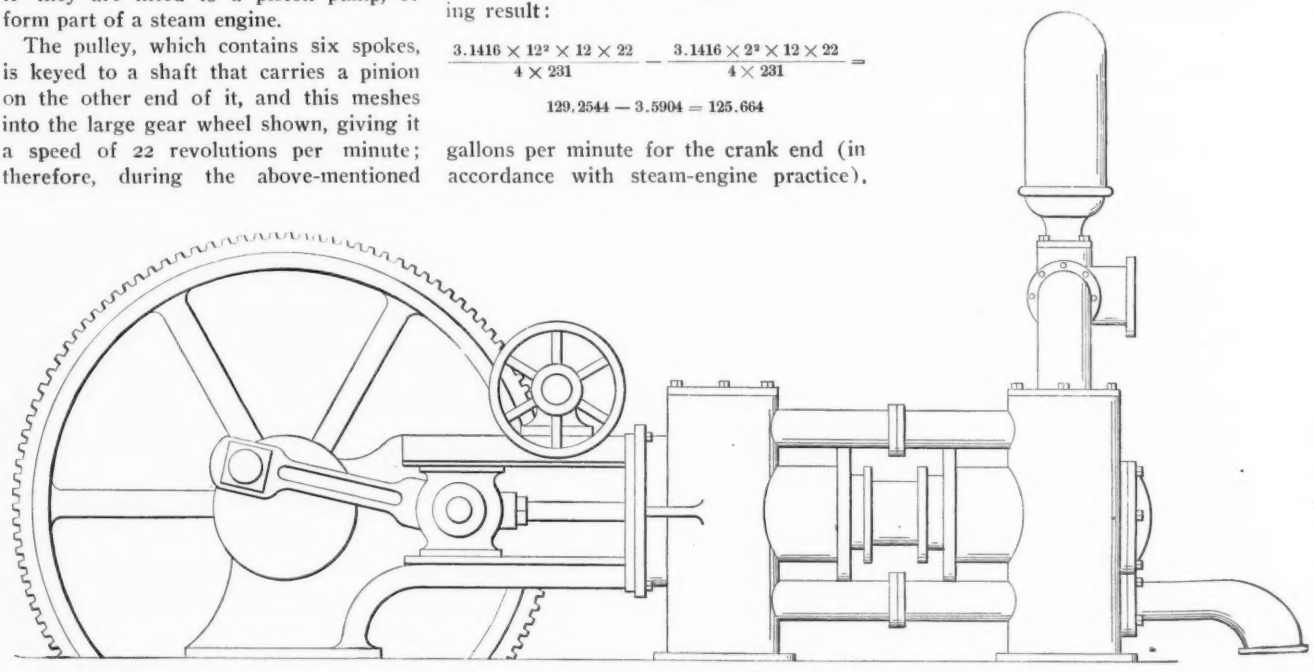


FIG. 1. ONE SIDE OF A DUPLEX POWER PUMP

former the result is the effective area and

$$113.0976 - 3.1416 = 109.956$$

square inches. The stroke is 12 inches, and there are 22 strokes per minute. When these three factors are multiplied together

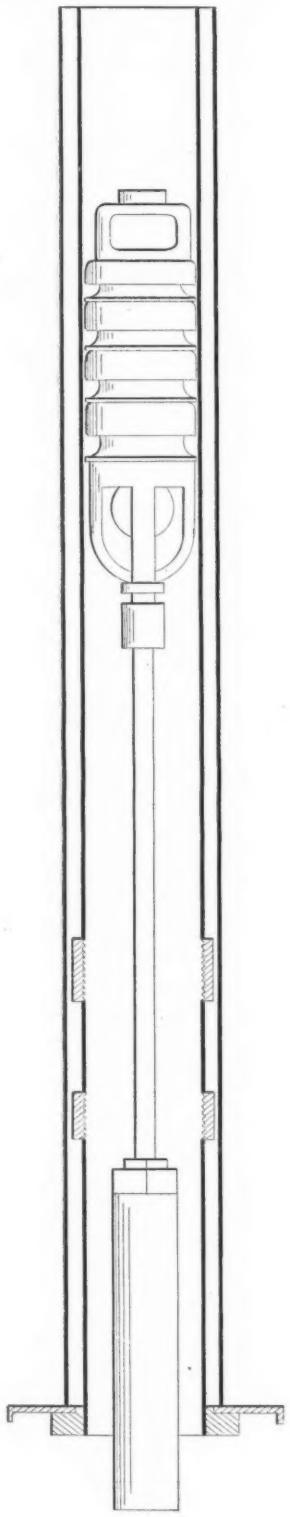


FIG. 2

and the product is divided by 231 the quotient is 125,664 gallons, which is the displacement of the crank end per minute.

As there is no rod on the head end, the total area is the effective area, and by applying the above rule the displacement of this end is found. Then,

$$113.0976 \times 12 \times 22 \div 231 = 129.2544$$

gallons per minute. Adding the displacement of both ends together shows that for the part illustrated in Fig. 1 the displacement is 254.9164 gallons, and multiplying this by 2 for a duplex pump determines that the total displacement is 509.83 gallons which agrees with the results secured by the use of the foregoing formula.

Difference between Displacement and Amount Delivered

The next point to be considered is the difference between the displacement as above defined, and the actual amount delivered in practice, and to point out the causes for this difference wherever it is found. It is sometimes claimed that the working capacity is reduced by a high speed, because the valves do not have time to seat perfectly, but this is a mistake, for it is not necessary for them to operate the same as when the speed is low.

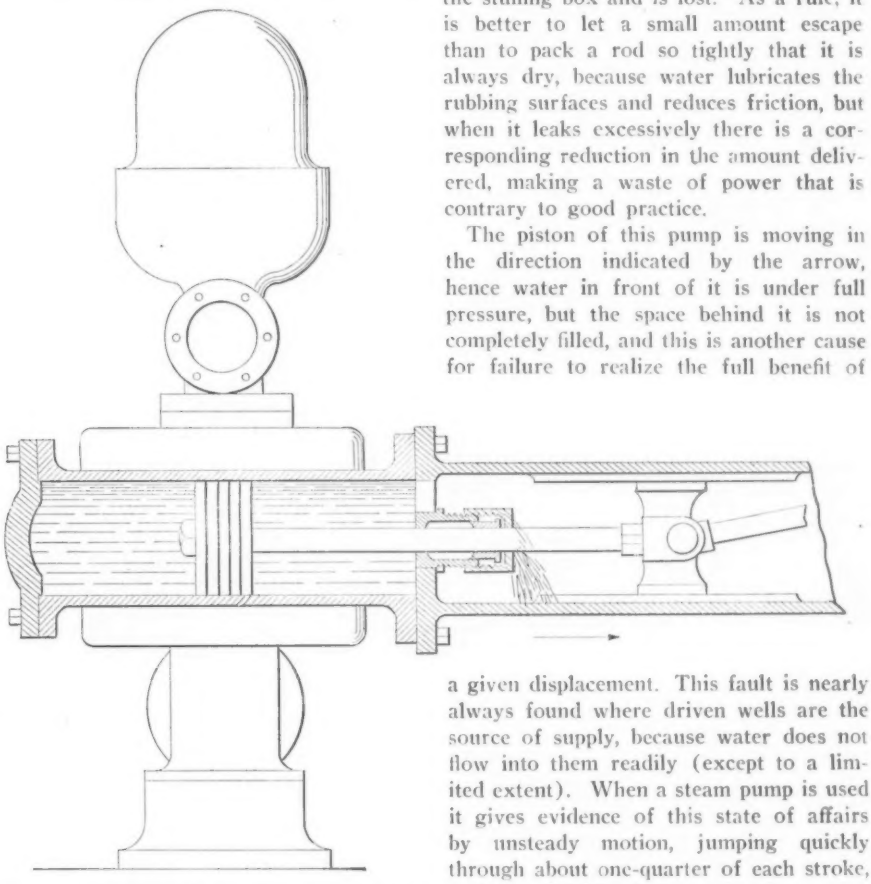


FIG. 3. SHOWING ONE CAUSE OF THE DIFFERENCE BETWEEN DELIVERY AND DISPLACEMENT

Fig. 2 is presented to illustrate this point. When the plunger is drawn upward rapidly it sets in motion a column of water, the momentum of which keeps it in motion for a short time after the plunger stops. The comparative length of time that it continues to move depends on the speed at which the plunger travels, and is, therefore, a variable quantity: consequently, its effect can only be estimated, unless a careful trial is made in each case, but it gives a greater capacity than the displacement indicates. This statement applies to average conditions, but if it does not prove to be correct in a special case it is due to the fact that water is not supplied fast enough to fill the pump cylinder at every stroke, and this is frequently the case where the supply is drawn from driven wells.

On the other hand, there are cases in which the actual delivery of water is less than the displacement indicates even at low speed. Fig. 3 illustrates one cause for this difference, as water leaks around the stuffing box and is lost. As a rule, it is better to let a small amount escape than to pack a rod so tightly that it is always dry, because water lubricates the rubbing surfaces and reduces friction, but when it leaks excessively there is a corresponding reduction in the amount delivered, making a waste of power that is contrary to good practice.

The piston of this pump is moving in the direction indicated by the arrow, hence water in front of it is under full pressure, but the space behind it is not completely filled, and this is another cause for failure to realize the full benefit of a given displacement. This fault is nearly always found where driven wells are the source of supply, because water does not flow into them readily (except to a limited extent). When a steam pump is used it gives evidence of this state of affairs by unsteady motion, jumping quickly through about one-quarter of each stroke, and then finishing it in good order.

The reason for this action is as follows: Fig. 3 shows a piston at one-half stroke, moving as indicated by the arrow. When this stroke is completed the space behind the piston is not full of water, therefore when the direction of motion is reversed the full force of steam acting on the steam piston sends it quickly back until the water is forced up into the upper part of the water cylinder, and the whole is filled, but to this point none is sent out. The piston has now traveled through about one-quarter of its stroke, and it then moves steadily onward until the stroke is finished. When a power pump is used, the same action may take place, so far as water is concerned, but the piston is driven steadily forward at the uniform speed desired, giving no indication of reduced delivery.

Still Another Source of Loss

When a water piston does not fill the cylinder some of the contents leak from the discharge side back into the suction side, and this is another source of loss. Fig. 1 is a plunger pump, hence any water that leaks past the plunger escapes to the floor, where it is readily seen, and this is one advantage of this kind of a pump.

Suppose that every part of a pump is in good order. At the completion of a stroke the discharge valves are open, but with a slow speed a small portion of water that ought to be delivered comes back through the ports before the valves close, and similar action takes place with the suction valves, although the water not secured goes back into the suction pipe.

On account of these possible and probable imperfections it is customary to make an allowance in the calculation, which the engineer thinks will cover all points, and for this particular case it is assumed that the losses amount to 10 per cent. of the total displacement, and as this amounts to 509.83 gallons per minute, the difference is 50.98 gallons, leaving 458.85 gallons as the net quantity delivered. It goes into a circular wooden tank located above the roof of a mill where it is difficult to obtain the exact dimensions of it, but the makers claim that it holds 20,000 gallons and this is probably correct. To find the time required to fill this tank, divide its contents by the amount delivered per minute. Then

$$20{,}000 \div 458.85 = 43.58$$

minutes required.

This tank is seldom empty, but when it became necessary to clean it one day a test was made to determine the time required to fill it, and in 45 minutes from the time of starting the engine the tank was overflowing to the sewer. It is not claimed that this was a very close and accurate test, so far as fractions of a minute are concerned, but it was near enough for all practical purposes. Taking the capacity of the tank and the time noted as correct, the above calculation agrees very nearly with actual results secured in practice.

Furnace Construction

By M. A. Sprague

For a number of years the writer has made a specialty of installing boilers of all kinds, with and without dutch ovens and extensions of furnaces for the burning of different kinds of fuel. One of the weakest points in the return-tubular settings appears to be in the construction of the brickwork directly over the fire doors and under the extension sheet, or at the forward end of the boiler. The usual hight of the boiler above the floor line, 4 feet 3 inches to 4 feet 6 inches, is not sufficient, 5 feet at least being better.

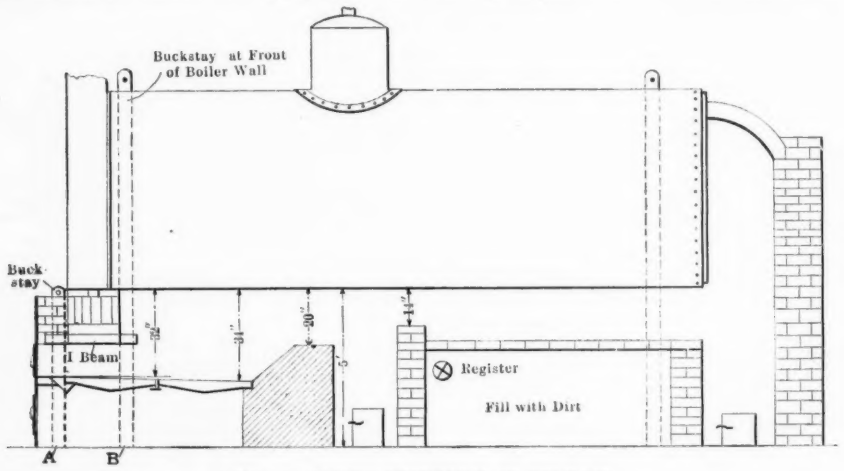


FIG. 1. SLIGHT EXTENSION OF FURNACE

The standard front usually has two fire doors, and they are necessarily so close together that there is not sufficient room between them for a good, substantial pier of brickwork to support the brick lining above. This pier is usually so frail that it cannot long withstand the rough usage generally received from a careless fireman, and being weakened or oftentimes destroyed, lets down the brick lining from under the extension sheet.

To remedy this trouble, the distance between the grate and shell of the boiler should be increased by raising the boiler to a hight of at least 5 feet above the floor line, or by sinking the furnace 6 or 8 inches below the floor line. This would give sufficient room to put a good, substantial arch clear across from one side of the firebox to the other, and independent of support from a middle pier. In dutch-oven construction, this distance between grate surface and boiler shell should be increased to offset the space the arch of the dutch oven occupies, which has to be low enough, of course, to go under the extension sheet. This brings it back to or past the end of the grate and over the forward face of the bridge-wall. Right here, again, the mistake is often made of not getting the bridgewall back far enough so as not to check the draft and retard combustion. See Fig. 2.

There are other reasons why a greater distance between the boiler and grate is desirable, especially on the Pacific coast and in the Northwest, the principal reason being the kind and quality of fuel, consisting for the most part of light, fluffy bituminous coal requiring a larger quantity in the furnace, in order to maintain the required degree of heat, than it does of the harder coal of the eastern States.

In Fig. 1 is a sketch illustrating how a boiler front can be bricked up in a substantial manner by an extension of about 12 inches. The farther this extension is carried, the greater in proportion will be the benefits derived in the way of a more complete combustion, on account of the increase in the length of the arch over the furnace, thus enabling the gases to come in contact with a greater area of heated surface and igniting before reaching the heat-absorbing surface of the boiler. Hence, if room will permit of so doing, this extension may with profit be carried far enough to be made into a dutch oven, which, rightly constructed, is an ideal furnace in a great many ways.

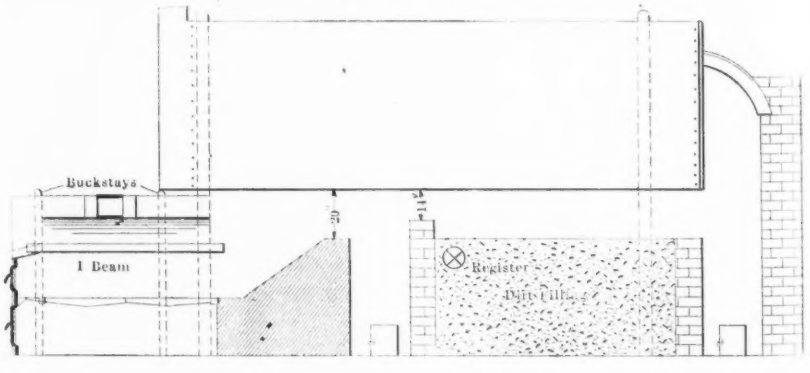


FIG. 2. EXTENSION INCREASED TO DUTCH OVEN

Apropos of the Drought

"Did you hear about Jones, the engineer down at the waterworks, being arrested and fined for cruelty to animals?"

"You don't say! How did it happen?"

"Well, you see it was during the late dry spell, and they say that Jones let his hydraulic ram go two weeks without water."

The Plunger Hydraulic Elevator

Directions for Renewing the Plunger Packing in Otis Elevators; Construction of the Stuffing Box Casting; How to Remove the Valves

BY WILLIAM BAXTER, JR.

To Renew Plunger Packing

Whenever it becomes necessary to renew the plunger packing, the first thing to do is to run the car downward until it rests solidly upon the bumpers. Then the hand valve in the supply tank should be closed, so that water cannot flow in from the pressure tank. If the discharge tank is higher than the bottom of the valve, which is generally the case, there

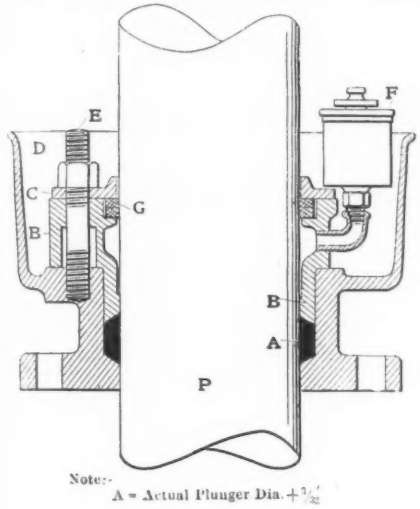


FIG. 269

will be a hand valve in the discharge, and this must also be closed so that water cannot flow back from the discharge tank. If any part of the pipe connections between the two hand valves just mentioned is higher than the top of the cylinder, there will be drain cocks through which the water may be drawn off, so that when the stuffing-box gland is removed water may not escape and flood the floor The way in which the stuffing box of the Otis plunger is repacked can be understood by the aid of the detail drawings of the box and packing presented in Figs. 269 to 273. Fig. 269 is a vertical section through the several parts of the structure. The stuffing is shown at *A* and the compressing gland is marked *B*. Between the gland *B* and a ring *C* are two rings of babbitt metal which are provided to rub the oil off the plunger as it ascends and prevent it from overflowing when the plunger comes down. As an extra precaution, however, the basin *D* is provided to catch any drippings of oil.

The packing *A* can be any of the soft kinds suitable for steam-engine stuffing boxes, but the Otis company makes a special ring packing in two parts, one of leather and the other of rubber, and this lasts longer and remains tight until worn out. A sectional drawing of this packing is given in Fig. 270. In this illustration *P* represents a portion of the side of the plunger, *B* is the lower end of the stuffing-box gland, *B'* is a portion of the stuffing-box casting and *A A'* are the two parts of the packing rings; the ring *A* is made of leather and *A'* is made of rubber. These two parts are made so as to just fill the stuffing-box chamber when the gland *B* is screwed down to the lowest position, as shown in Fig. 269, hence, the packing is held securely in place but not compressed. Two rings are used because it is necessary to cut them on one side to put them in place without lifting the

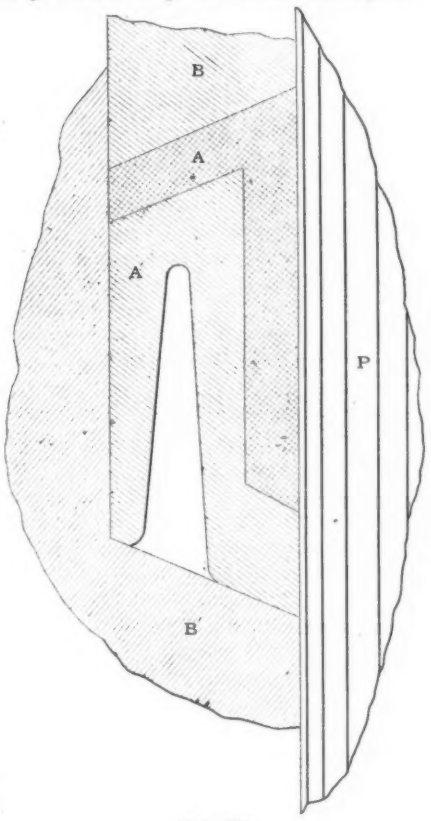


FIG. 270

plunger out of the cylinder, and by using two rings and "staggering" the cuts, a tight joint can be made. The two rings are made to fit each other; the pressure of the water acts against the inner sides of *A'* and forces the outside part against the stuffing-box casting, making a tight joint at this point, and the inside part is forced against ring *A*, making a tight joint between the two rings, at the same time forcing *A* against the plunger to make a tight joint at this point.

The Stuffing-box Casting

The construction of the stuffing-box casting is clearly shown in Fig. 269, and the construction of the gland *B* is more fully illustrated in Fig. 271, which shows a plan view and a sectional elevation. This latter view shows that between the top

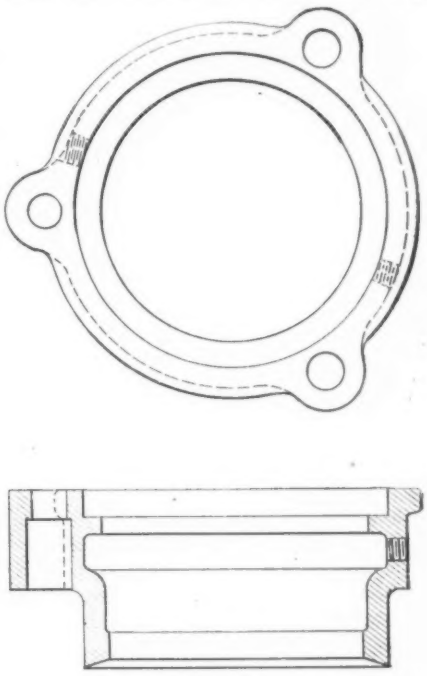


FIG. 271

and bottom edges of the casting there is an annular recess which forms an oil well that surrounds the plunger and keeps the surface of the latter well lubricated. Oil flows into this recess from the oil cup shown in Fig. 269. At the upper end of the gland there is another recess which contains the babbitt ring scrapers that wipe the oil off the plunger as it rises. To hold these in place the ring shown in Fig. 272 is provided, and this is held in position by the studs *E*, Fig. 269, that hold down the gland *B*. The babbitt rings are of square cross section, as shown in Fig. 273, and are divided into halves, the ends being cut on an angle as shown at *A*. On the outer surface of the ring is cut a groove that is large enough to accommodate a brass-wire spring, which presses the two halves of the ring against the plunger surface. Two of these rings are used, as shown in Fig. 269, and they are set so as to break joints.

To determine whether the plunger stuffing box needs repacking is a very simple matter. If it leaks it must be repacked, unless it is filled with an ordinary packing in which case it may possibly be made tight by screwing down the gland *B*. As the top of the cylinder is in sight, water running out of the stuffing box can easily be seen. If it is not known whether the packing is of the type shown in Fig.

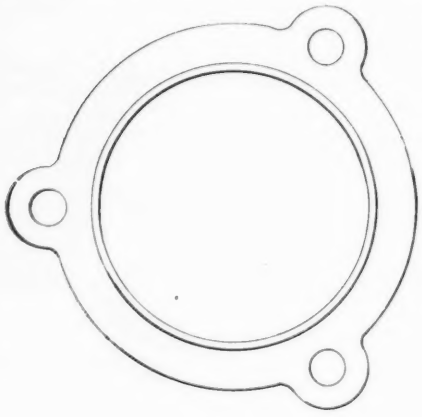


FIG. 272

270 or not, this can easily be determined by feeling around the outside of the upper flange of the gland *B* to ascertain whether it is resting against the lower casting or not. If it is not down tight, the packing is probably hemp, and a few turns of the studs may be sufficient to prevent the escape of water. If gland is down against the lower casting, the packing may be rings, such as shown in Fig. 270, that are worn out, or hemp that is compressed as far as the gland will force it. If it becomes necessary to renew the packing and there are no packing rings at hand, use hemp well greased, and if this works well, keep on using it. It is by no means certain that the rings will work better than hemp, although they are considered to be able to stand up better against the wear of high-speed plungers.

If a plunger elevator settles when standing at a landing above the first floor, and no water escapes from the plunger stuffing box, the valves leak, that is, providing the valve is properly closed. To renew the packing it is necessary to remove the valve from the casing, and before this is done the hand valves in the supply and discharge pipes must be closed and the water drawn from the valve casings. The car must be run down so as to rest on the bumpers at the lower floor before this work is begun. The hand-rope valves used with freight elevators are best removed through the upper end, although it is also possible to remove them from the lower end, providing there is space between the bottom of the valve cylinder and the floor for their removal. This way of taking out the valves is not advisable, however, because it involves disconnecting the discharge pipe, which is considerable work; nevertheless, there may be cases where the location of the valves renders this method necessary.

When the valve is removed through the upper end, if it is of the lever type, the pivot pin around which the lever swings is taken out so that the lever may be removed, and then the valve can be lifted out of the cylinder. If the valve is of the rack-and-pinion type, the casing that covers the rack is removed together with the pinion and shaft, and then the valve can be drawn out. If the valve is of the double-gear rack-and-pinion type it is only necessary to remove the shaft that holds the pinion that meshes with the rack, and also the covering of the latter; with these parts removed, the valve can be drawn out. If the brass lining of the valve cylinder happens to be in two parts there may be some difficulty experienced in passing the cups of the lower valve pistons up into the upper lining, but if this occurs the valve should be lowered so as to smooth up the cups, and then tried again with more care. There is very little liability of having trouble in this direction, because the lower end of the top cylinder lining is made with the inner corner well rounded off and the top end of the lower lining is made in the same way. There is no difficulty in getting the valve back into the cylinder, because the cup packings are not forced in edge first, or against the grain, as it might be expressed.

Removal of the Valves

The main valve of passenger elevators is removed from the back end, as it cannot be removed from the front end, owing to the fact that the rear piston is larger than the others. In the twentieth-century valve, the upper valve pistons can be removed from either end, as all the pistons are of the same size; but it is less trouble to remove them from the back end, as then it is not necessary to disturb any of the connecting levers.

When new leather cups are to be put in the valves they should be obtained from the makers, so that they may be of the proper depth. In some cases it matters little what the depth of the cup is, so long as it makes a tight joint; this is the case with the pistons in the lower cylinder of the twentieth-century valve, because the packings have only to main a tight joint. There are cases, however, in which the edge of the cup forms the edge of the valve, and when it passes over a port, closes it and stops the flow of water. To make the elevator work well it is necessary for such valves to have a certain amount of lap, and therefore the cup packing should be of the proper proportion. In the several valves illustrated in previous articles describing the Otis passenger plunger elevator, for example, it will be noticed that in the valve piston which shuts off the flow of water from the supply pipe into the cylinder the cup is turned toward the supply pipe, hence its edge forms the edge of the valve and its length determines the amount of lap, so that if the cup is too deep there will be too much lap and if it is too shallow there will not be enough lap.

Of the two evils, too much lap is the lesser, so that if for any reason a cup is used that is not of the proper shape, take one that is deeper than it should be. If the lap is reduced the liability of reversing the elevator whenever it is stopped is increased, because a slight movement beyond the point where the valves are closed will open them for the reverse direction of movement. These observations relative to the proportions of cup packings apply to simple hand-rope valves as well as to the pilot-valve type.

The pilot valve and the *V* valve can be removed from either end when it becomes necessary to renew the packings, but generally it will be found easier to draw the pilot out through the back end and the other valve through the front. In replacing the valves they can best be put in through the back. If any trouble is experienced in getting the front cup of the pilot valve past the two port openings, the trouble can be avoided by putting the valve in from the back with the two rear cups in place, and then the front cup can be put on from the front end. In doing this, care must be taken that the end fork which holds the connecting-rod end is screwed upon the valve rod tight, so as to force the packings firmly into position. The safest course is to note the position of the end of the valve rod in

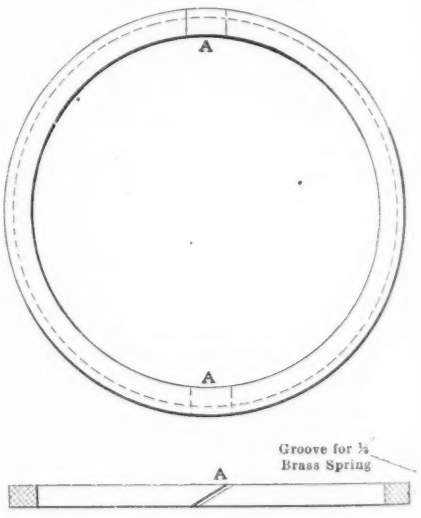


FIG. 273

the fork before taking it apart, and to screw it up to that same position when putting it back. This plan should also be followed with the nuts at the back end.

Referring to the drawings of the Otis plunger-elevator pilot valves, as well as the main valves, it will be found that no means are provided for adjusting the position of the cup packings lengthwise of the piston rod; such adjustment is not

provided because it is not required. When the valves are made the various parts are made of the proper length to bring all the cups in the proper positions, and the only way in which the adjustment can be made wrong is by using cups that are not of the proper length when replacing those that are worn out.

Diagram for Determining Piston and Crank Relations

By S. Shibata

It is often desirable to know the percentage of piston displacement for particular positions of the crank pin. As is well known, owing to the angularity of the connecting rod the piston occupies a different position in the cylinder from what it would if the piston travel corresponded with the longitudinal position of the crank pin. In the accompanying diagram the actual piston displacement has been worked out for connecting-rod lengths of from 4½ to 6½ crank lengths.

To use the diagram it is necessary to know the position of the crank in degrees and the length of the connecting rod in crank lengths; for example, if it is desired to know the position of the piston when the crank stands at 23 degrees on the forward stroke and the connecting rod is six cranks in length, lay a ruler from the center to the 23-degree graduation on the forward stroke and the displacement is found to be 4.6 per cent. of the cylinder volume, neglecting clearance. On the return stroke it is found in the same manner to be 3.3 per cent. of the cylinder volume, and for all other positions of the crank the displacement may be found in the same manner.

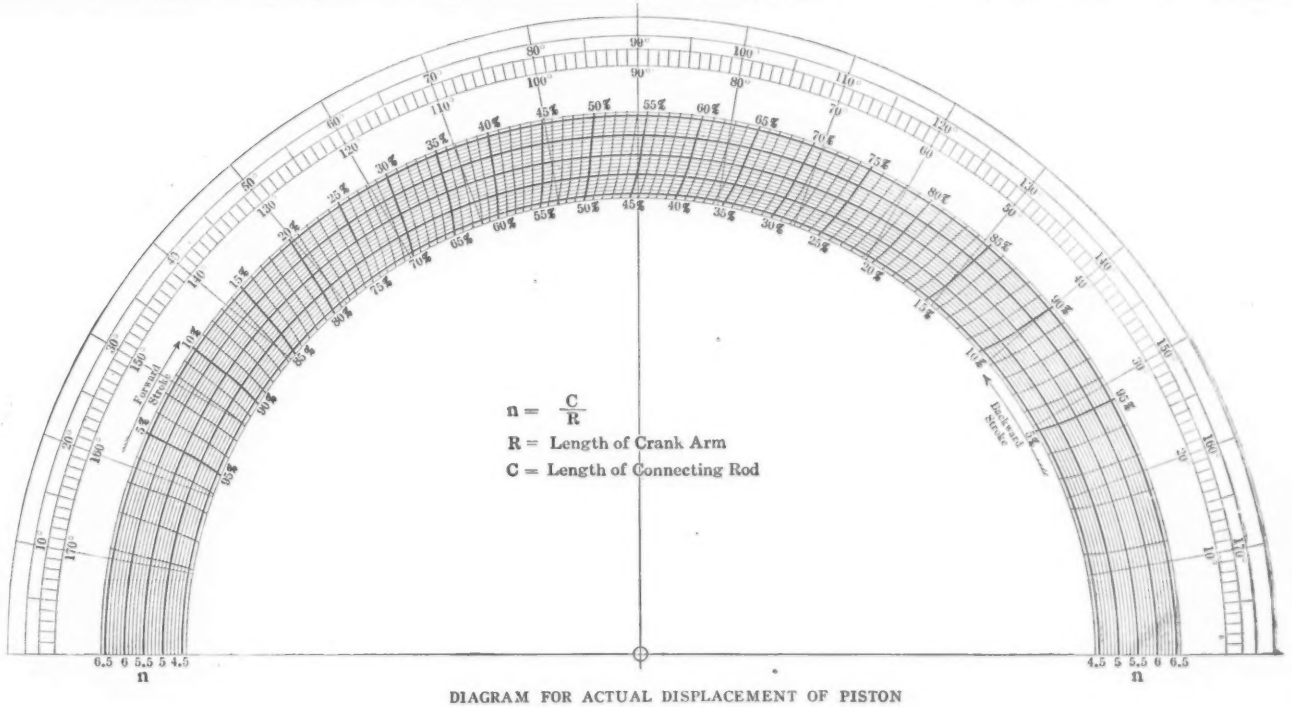


DIAGRAM FOR ACTUAL DISPLACEMENT OF PISTON

A Few Principles of Oil Separation

By H. A. Cozzens, Jr.

There are no doubt many principles on which the operation of the numerous types of steam separator are based, but comparatively few makers embrace all of these principles in one type of separator. The principle of expansion is one of the foremost and is used to advantage in nearly all types. The steam, on entering the separator, is expanded and this expansion is accomplished by using a separator which has a steam area greater than that of the entering steam pipe. In the operation of steam separators expansion is advantageous, in that the steam, when expanding, decreases in density to such a degree that the fine particles of oil and impurities contained in the steam before the expansion will not be supported in the rarified steam, and the impurities will drop into the lower part of the separator by force of gravity and thereby be removed from the steam.

Another principle on which the operation of steam separators is based is the reversal of the direction of the incoming jet of steam. It is no doubt known that if a mixture of steam and the numerous impurities which may be generally found in exhaust steam, as water, oil, grease and other refuse, is traveling in one direction, but is suddenly diverted from its original course, the steam and oil will separate. In the first place the specific gravities or weights of the steam and of the oil are different, and, therefore, the momentum in one case will be greater than that of the other. Then the elasticity of the steam is greater than that of the impurities, so that when the steam strikes a baffle plate it will rebound and accomodate itself to the change of direction much faster than the water or oil, which in most cases will not rebound at all, but will cling to the surface of the baffle plates and run into the receiver. It may be thus seen that momentum and elasticity play a great part in the separation of oil from steam.

Those separators which make use of the principle of centrifugal force, also make use of the principle embodying the difference in weight between steam and oil. Thus, when the steam, after passing through the spiral-shaped baffle used in this type of separator, is given a whirling motion, the impurities contained therein are separated and thrown onto the sides of the apparatus. This is accomplished because the oil is heavier than the steam and cannot accustom itself to the change of direction as rapidly.

The following may not be a principle, but it is at least a basis on which most separators are designed and operated: The greater part of the oil contained in steam is carried along in the lower portion of the pipe. Many separators, therefore, make provision to catch this oil and separate it from the steam before it has a chance to strike the baffle plate. The means of doing this is by using a high recurved flange, placed inside the separator just where the entering pipe terminates. The oil in moving along the bottom is caught in the trap and is conducted by gravity into the receiver.

Location of the separator is another feature to be considered. When a cheap grade of oil is used for lubricating purposes, it will generally be atomized by the high temperature to which it is exposed, and the separators which guarantee to separate oil in this condition are few.

A Large Suction Gas Producer Power Plant

A Description of One of the Largest Suction Plants in the United States, with Reference to Special Features of Engine and Producer Design

It is estimated that there are now 500 producer power plants of both suction and pressure types in the United States, aggregating 150,000 horsepower. About 85 per cent. of this number are suction plants, which average approximately 100 horsepower each. When it is considered that after the period of development, in adapting the suction producer to American coals, there was necessarily an experimental stage of two or three years in order to thoroughly test these installations in everyday service in the field, then the significance of what has been accomplished becomes apparent.

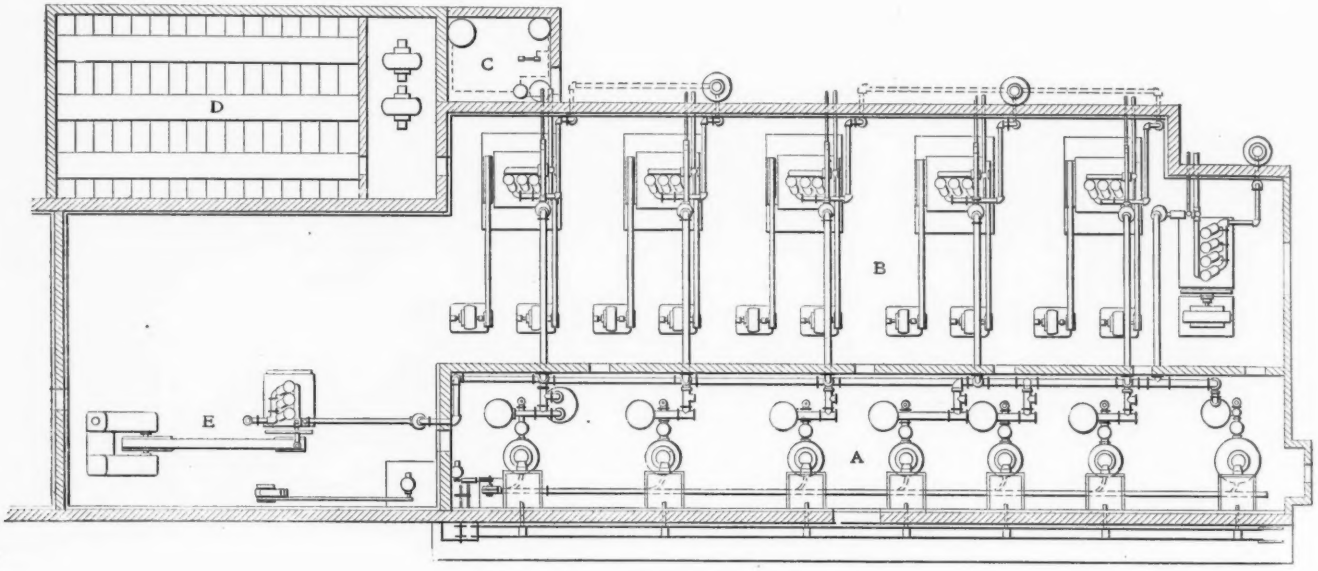


FIG. 1. PLAN VIEW OF PRODUCER PLANT

The Plant in General

One of the largest suction gas-power installations in the United States is in daily service at Beloit, Wis., at the works of Fairbanks, Morse & Co. The producers, engines and electric generators are exclusively of Fairbanks-Morse design and construction. The works cover nearly 50 acres, and under normal conditions 2200 men are employed. In all there are some 20 shop buildings, of which the main gas-engine machine shop is about 90x700 feet, the erecting shop 70x300 feet, and the testing department 85x325 feet. The power house is a one-story structure 44x232 feet. A plan view showing the layout of the power house is illustrated by Fig. 1, and a sectional elevation is shown in Fig. 2.

Power for nearly all of the shop buildings comprising the complete works is developed at this central-station plant. The power equipment includes: Five 150-horsepower three-cylinder vertical producer-gas engines, each belted to two 50-kilowatt 130-volt direct-current generators by means of belting from the two flywheels on each engine; one 200-horsepower four-cylinder vertical producer-gas engine direct connected to a 135-kilowatt 250-volt direct-current generator, and another 150-horsepower three-cylinder vertical unit belted to a two-stage air compressor, furnishing compressed air for operating pneumatic tools and pneumatic hoists scattered throughout the works. A partial view of this equipment is shown in Fig. 3. Each engine is provided with a separate suction gas producer of the same rated size as the engine, and the arrangement of the piping is such that the different engines can be operated interchangeably on the other producers, as desired. The producer room is parallel to the engine room, and the two are separated by a partition in order to keep the engine room free from dust.

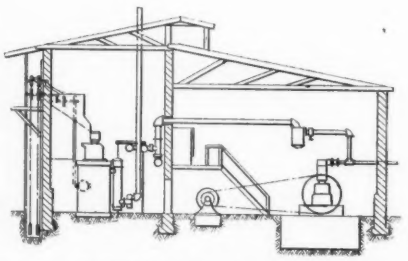


FIG. 2. SECTIONAL ELEVATION THROUGH ENGINE AND PRODUCER ROOMS

The first 150-horsepower engine of the plant was started in February, 1905, and has continued in daily service ever since. This engine, as well as the other four 150-horsepower units used for electric service, carries a load of 700 to 900 amperes, 20 to 24 hours a day, and six days a week. Provision has been made for extending the end of the power house to accommodate several more 200-horsepower units as soon as the growth of the works demands these additions.

Electrical Equipment

The present plant takes the place of a large number of small engines which were previously scattered throughout the works, from which power was transmitted by means of belting. Power is now distributed to the various shops by means of electrical transmission to a large number of electric motors, each located near the machines to be operated, and in some cases, direct connected. The Edison three-wire system has been installed, so that the motors can be operated at 250 volts and the lights at 125. The load consists of 75 motors ranging from 1 to 60 horsepower each, having a total of approximately 1100 horsepower, nominal rating; 320 arc lights, and 2140 incandescents. The 50-kilowatt 130-volt generators are operated in pairs on the three-wire system, each set of two generators being in parallel with the other four sets.

The 135-kilowatt 250-volt generator, which is direct connected to the 200-horsepower engine, is operated on the outside wires in parallel with the others. The switchboard is located in the engine room on a gallery above the generators, and is bracketed to the partition between the engine and producer rooms.

To maintain good regulation a storage battery is operated in conjunction with a motor-driven booster set, adjusted to maintain the generator load approximately constant and to throw the fluctuations upon the battery. The storage battery and booster were installed by the Electric Storage Battery Company, of Philadelphia, and in addition to the regulating duty, it serves to relieve the station of a part of the peak load, which, during the winter months, is very heavy during the latter part of the afternoon. It is also available in case of emergency, as on Sundays and holidays when the engines are shut down. This dispenses with the services of a number of men at times when the works are not in actual operation, and furthermore, the storage battery affords opportunity for overhauling the engines or cleaning the producers. The battery has 127 cells, and with the booster occupies a space 26x54 feet; its location is denoted by *D* in Fig. 1. The normal discharge rate for eight hours is 260 amperes, and the maximum discharge rate for one hour is 1040 amperes. The normal charge rate for eight hours is 260 amperes and the maximum charge rate, 360 amperes, the voltage being 262.

In Fig. 4 is shown a load curve for a day taken at random. No effort was made to select a load showing any peculiar load conditions, and it may be assumed to be a fair example of the load at any time during the fall of the year. During some of the winter months, when the days are shorter, the peak load will be somewhat greater. The curve shows the battery discharge during the daytime, when the load is heaviest, and being charged at night, when the regular load is light.

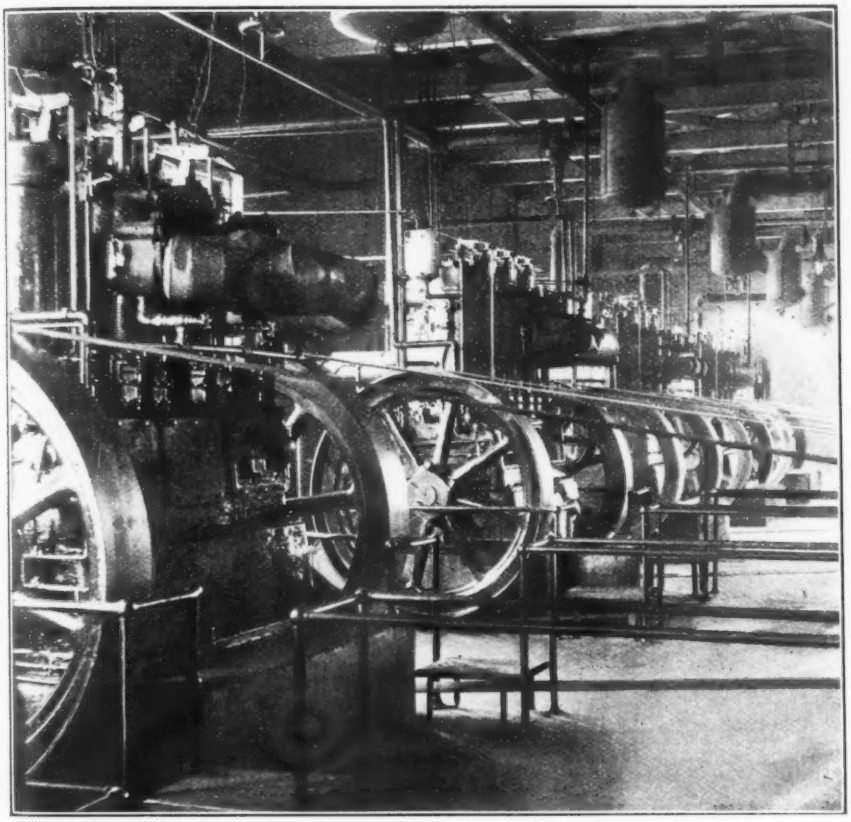


FIG. 3. LOOKING DOWN THE ENGINE ROOM

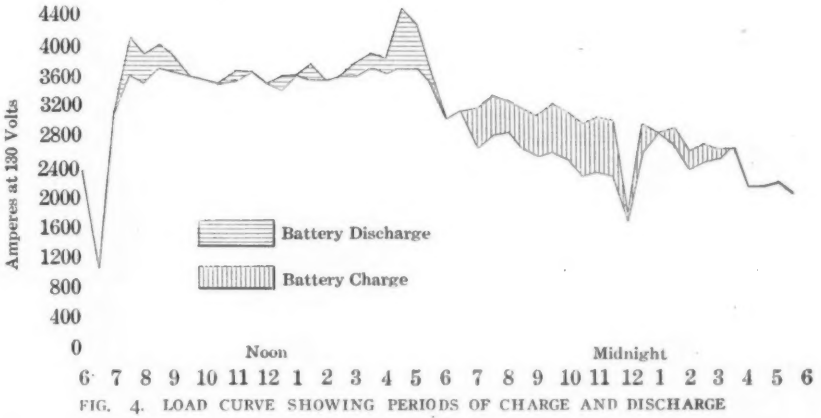


FIG. 4. LOAD CURVE SHOWING PERIODS OF CHARGE AND DISCHARGE

The Producers

To make gas for the six 150-horsepower engines and the one 200-horsepower engine, there are installed six 150-horsepower and one 200-horsepower suction gas producers. The fuel used is either buckwheat or pea-size Pennsylvania anthracite. An exterior view of a 150-horsepower producer is shown in Fig. 5, and a sectional view in Fig. 6. All of the principal features are clearly shown. Coal is admitted to the producer through a hopper at the top. This has double closure, so that fuel can be introduced without admitting air. The fuel is fed to the hopper of each producer from a large overhead hopper, filled by means of a coal elevator which lifts the fuel on an endless conveyer from the storage bins.

In the larger producers used in this plant, the vaporizer is separate and connected to the side of the generator by piping, but with some of the smaller sizes the vaporizer is located at the top of the producer. The wet scrubber is a cylindrical tank nearly filled with coke, over which a spray of water is constantly sprinkled. Between each producer and engine opposite is located a small gas tank which acts as a moisture separator, and also provides a reserve supply of gas for the engine. All of the apparatus through which the gas passes, including the piping, is fitted with hand-hole plates, located so that all parts are accessible for cleaning.

In caring for the producers the fires are cleaned from below once every three hours, and are poked down from above about once an hour through pokeholes provided in the top of the producer. The usual three-way or bypass valve is fitted in the gas pipe between the vaporizer and the scrubber. When the engine is not running, or when the fire is being started in the producer, this three-way valve is opened to atmosphere.

The Engines

All of the engines are of the multicylinder vertical type. Each 150-horsepower unit has three cylinders and the 200-horsepower engine has four cylinders. They are all four-stroke machines, especially designed with high compression for operating on producer gas, and all of them run at a speed of 250 revolutions per minute. An illustration of the 150-horsepower engine is presented in Fig. 7. This view, which is sectional in part, will

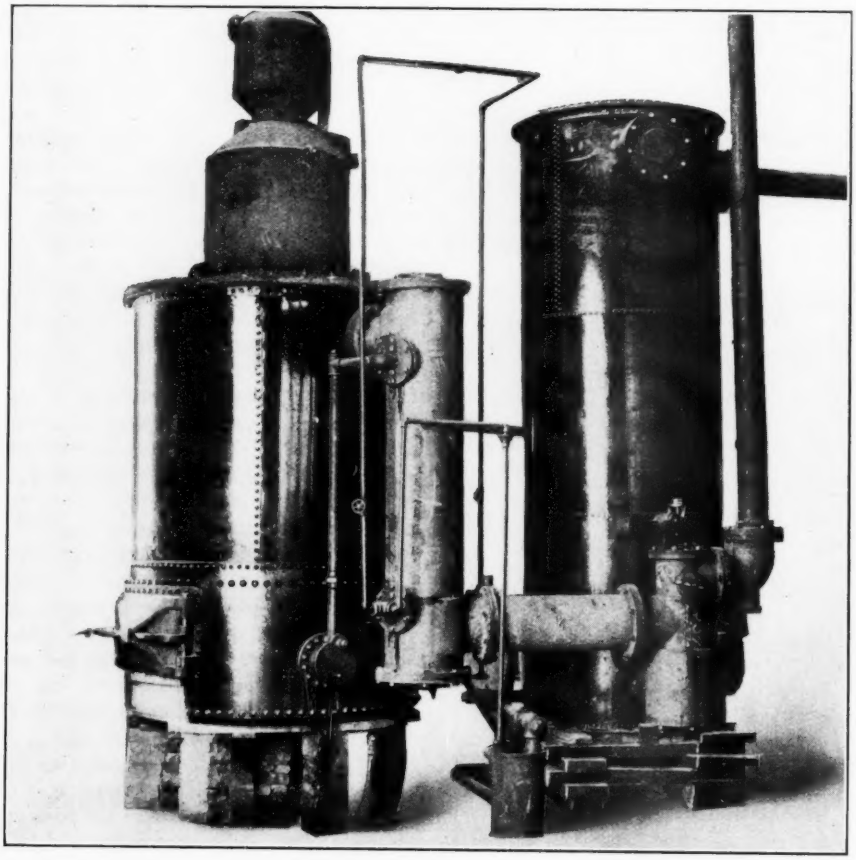


FIG. 5. ONE OF THE 150-HORSEPOWER SUCTION GAS PRODUCERS

from the different bearings collects in the base of the engine, which is drained by means of a small pump. This oil is run through a filter and is then used over again. The amount of oil actually consumed by each engine, when in continuous operation for a day of 24 hours, amounts to about two gallons. Each engine is fitted with a hand-operated speed regulator, and one cylinder of each engine is fitted with an automatic compressed-air starting gear, which can be thrown into or out of action by the movement of a lever.

Fuel Consumption and General Comments

The works are operated 20 to 24 hours each day, excepting Sundays and holidays. Five men handle the seven engines, seven producers, generators, and other apparatus—1100 horsepower in all—for each shift of 12 hours. In addition, one man acts as chief engineer. There was previously in use at these works a Corliss engine-steam plant, run noncondensing, with water-tube boilers using Illinois soft coal as fuel. While it is difficult to make accurate comparisons as regards fuel consumption, yet as a matter of general interest, it may be stated that the steam plant required approximately 3⅔ times as much coal per unit of power developed as the present producer-gas power plant.

SUMMARY OF DATA OBTAINED IN TESTS.

Load.	B.H.P. on Engine.	Speed, R.P.M.	Coal in 24 Hours.	Coal Per B.H.P. per Hour.	Cooling Water per B.H.P.-Hour, Gal.	Steam Per Pound of Coal, Lb.	Incombustible Ash, Lb.	Combustible Lost in Ash, Lb.	Combustible in Ash, Per Cent.	Per Cent. of Total Combustible Lost Through Grate.
¼	38.0	228	1590	1.74	13.1	0.35	191.5	50.7	26.5	3.19
½	75.4	226	2369	1.30	6.8	0.41	272.0	51.7	19.0	2.18
¾	113.1	226	3185	1.13	5.6	0.45	409.0	69.2	16.9	2.17
Full	149.4	224	3838	1.07	5.0	0.48	495.5	117.3	23.7	3.06

indicate the general construction and necessitate only a brief mention of the principal features of the engine. Make-and-break igniters are employed, and these can be adjusted to spark as early or as late as desired by means of a hand lever, which controls the time of ignition for all cylinders. In addition, there is an independent adjustment for each igniter, which is operated by a drop cam. The igniters can be readily removed, inspected and cleaned, and their location is shown in Fig. 7. Both admission and exhaust valves are mechanically operated from a cam shaft, located inside the crank case and driven by two-to-one reduction gearing including pinions made of alternate layers of steel and red fiber to reduce the noise. The governor is of the flyball type and arranged to operate a balanced disk valve controlling the gas supply.

Lubrication is effected by means of an elevated oil reservoir, which is provided with a separate brass pipe and individual sight feed for each bearing. The drip

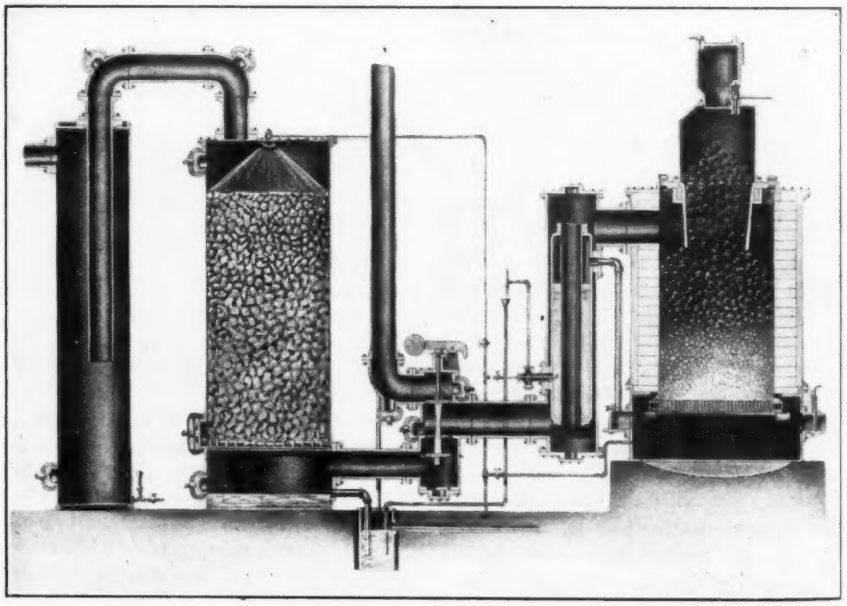


FIG. 6. SECTIONAL VIEW OF PRODUCER

A series of tests has recently been made on one of the 150-horsepower engines and producers, for continuous runs of 24 hours, at ¼ load, ½ load, ¾ load and full load, the object being to determine the comparative economy at different loads. The coal used was an ordinary grade of buckwheat Pennsylvania anthracite, running rather high in ash, the analysis being as follows:

Fixed carbon, per cent	78.9
Volatile, per cent	5.3
Ash, per cent	13.0
Moisture, per cent	2.7
Sulphur, per cent	0.77
B.t.u. per pound as fired	13,590

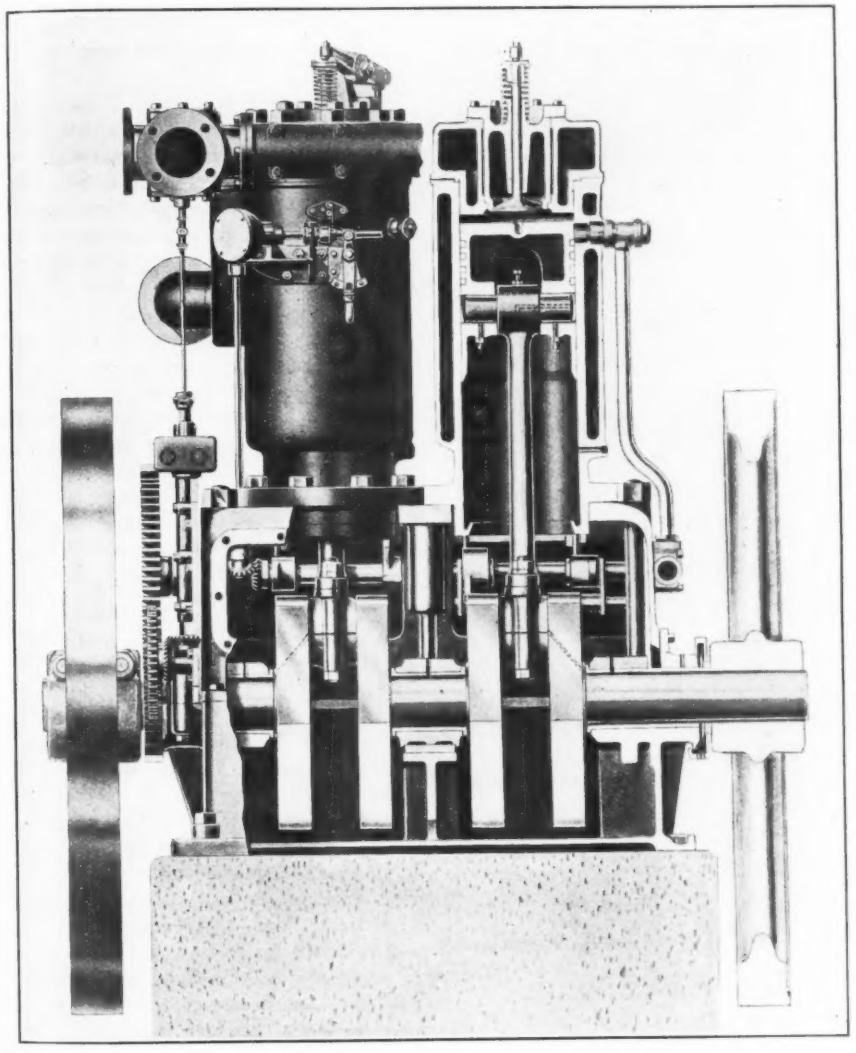


FIG. 7. PRODUCER GAS ENGINE SECTION

Some of the results of these tests, including the coal consumption per brake horsepower-hour, are given in the accompanying table. Economy tests have often shown a lower consumption than the values given, frequently less than one pound of coal per brake horsepower-hour at approximately full load. The figures presented are of value as giving the comparative fuel consumption at different loads, and for this purpose they may be considered as conservative and accurate.

The Parallelograms of Forces

By Fred G. Schanz

If two forces act on a body, it will move to the same point, whether the two forces act at the same time or in succession. To illustrate this law of mechanics, take for instance a ship moving from A to B, Fig. 1, and a person walking on deck from C to D. According to the law given above, the person will reach the point D', whether he walks from C to D first, and then the ship moves from A to B, or *vice versa*, or person and ship move together. This law only states the location of the point where the motions came to an end, but does not say in which way the point D' is reached. This may be done either by way of C over D to D', or from C over C', to D', or on line E connecting C and D'.

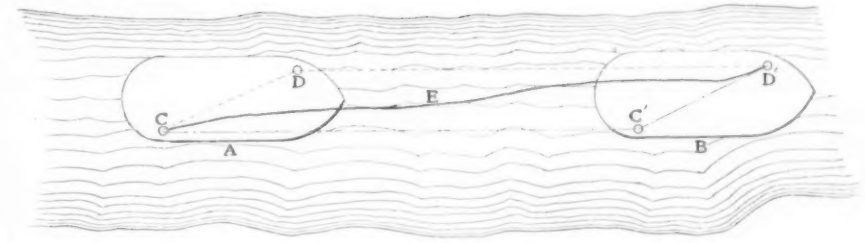


FIG. 1

FIG. 2

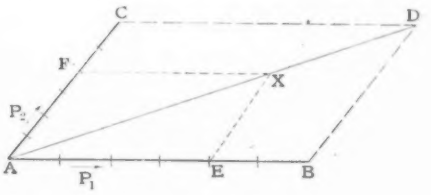


FIG. 3

If a body receives two impulses at the same time, one from A to B and the other from A to C, as shown in Fig. 2, the actual path of the body is obtained by moving line $A\,C$ parallel to itself on line $A\,B$, while the body moves on line $A\,C$. If the motion from A to C is completed in the same time as from A to B, the body will be at the point D, which is the fourth corner of a parallelogram with the sides $A\,B$ and $A\,C$.

Considering the path on which the body reached D, we assume that the speed of the body was constant in either direction. Thus let P_1 represent the constant speed in the direction $A\,B$, and P_2 the constant speed in the direction $A\,C$, Fig. 3. From this it can be easily seen that

$$A\,B : B\,D :: P_1 : P_2.$$

If the body had been stopped at F the speed P_1 would have brought the body to E in the same time, as the rates of speed in each direction are proportional. Drawing parallel lines to $A\,B$ and $A\,C$ from the points F and E, shows that the body has reached point X, which lies on a straight line connecting A with D, or in other words, on the diagonal of the parallelogram $A\,B\,D\,C$.

Let the lines $A\,B$ and $A\,C$, in Fig. 3, represent two forces, whose magnitudes are 200 and 120 pounds respectively, and if ½ inch represents 40 pounds, it can easily be found by measuring line $A\,D =$

3⅝ inches, that the body will be moved with a force of 290 pounds on a straight line toward D. Thus:

$$\frac{1}{2} = 40 = 3\frac{5}{8} = y,$$

$$y = \frac{40 \times 3.625}{0.5} = 290$$

pounds. This line AD is called the resultant of the two forces AB and AC, and represents the magnitude and direction of the force which moves the body. AB and AC are called the components of the force AD, and parallelogram $ABDC$ is the parallelogram of forces.

If the two forces act at an angle of 90 degrees, as shown in Fig. 4, the value of the resultant may easily be found by calculation. In this case R is the diagonal of a rectangle or the hypotenuse of the right-angled triangle ABD. Therefore

$$R = \sqrt{200^2 + 120^2} =$$

$$\sqrt{54{,}400} = 233.24$$

pounds. If the forces act in opposite directions, Fig. 5, the resultant R will be

$$200 - 120 = 80$$

pounds in the direction of AB. With the two forces acting in the same direction

$$R = 200 + 120 = 320$$

pounds.

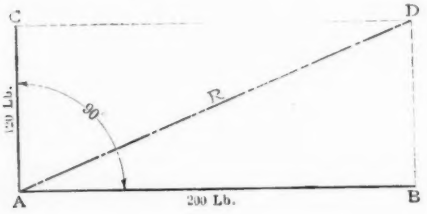


FIG. 4

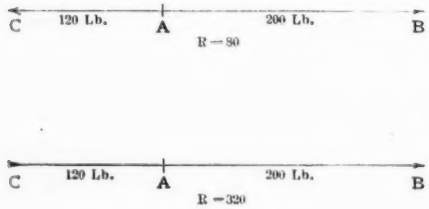


FIG. 5

Two forces of the same magnitude, but acting in opposite directions on a body, are in equilibrium, and the body is at rest. In many cases a single force has to be resolved into two forces, which act on a body in the same manner as the single force. To find the two forces representing a single force, AC in Fig. 6, with a certain direction, draw the parallelogram $ABCD$ with the single force as the diagonal. Since it is possible that an indefinite number of parallelograms with the same diagonal AC can be drawn, for instance parallelogram AB_1CD_1 or $ABCD$, the resolution of forces will be of practical use, only when the directions of the two single forces are known. Take, for example, a pillar crane, Fig. 7, having a load of 1000 pounds at A in the direction AP. What will be the tension in the tie rod T, and the compression in the strut C, if the length L at the pillar is 11 feet, the tie rod T 14 feet, and the strut C 19 feet long? Suppose that the scale used is 1 inch equals 1000 pounds.

Drawing the parallelogram $AEPD$

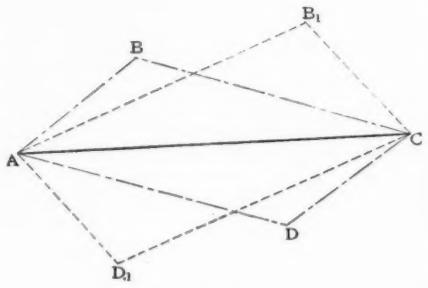


FIG. 6

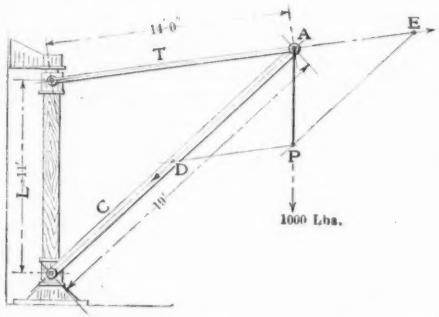


FIG. 7

over AP as diagonal, the sides having the directions of C and T, we find that

$$DP = AE = 1.255$$

inches, and

$$AD = EP = 1.727$$

inches. As 1 inch represents 1000 pounds,

$$1.255 \times 1000 = 1255$$

pounds, and

$$1.727 \times 1000 = 1727$$

pounds. These figures represent the tension and compression in the two members. As it is known that the diagonal divides a parallelogram into two equivalent triangles, it is sufficient to draw only triangle APD in order to get the value of the two forces T and C.

Guests of the Edison Company

Tuesday evening, October 13, the New York Edison Company tendered an entertainment and smoker to the electrical contractors of New York City, in connection with the New York Electrical Show, the place of assemblage being the concert hall of Madison Square Garden.

Light and Power Plant for Twillingate, Newfoundland

Boston capital has become interested in modernizing the city of Twillingate, Newfoundland, and will establish a plant for electric light and power. This will be the third such plant in Newfoundland. Conditions at Twillingate are peculiar, insofar that at present the only light is furnished by kerosene oil at from 25 to 35 cents per gallon, there being no gas and no possibility of ever having it, thus eliminating a feature which counts so very largely in the majority of such instances in the United States.

The city has a population of more than 11,000 within a radius of four miles and the plant will start with about 6000 lights, including 500 street lights. The charter of the Twillingate company is direct from the government and covers the entire district, which embraces an area of about 40 miles and contains a population of over 72,000.

The plant will consist of two 250-kilowatt steam-turbine units, it being deemed unwise to depend upon the water power at hand. The plant is being installed under the supervision of Frederick S. Palmer, 103 Bedford street, Boston, Mass., who is president of the company and who has associated with him several well-known Boston and Newfoundland financiers.

Water Power Development at Great Falls, Mont.

Plans are being perfected by Charles T. Main, engineer, Boston, Mass., for the immediate development of two powers near Great Falls, Mont. The upper development is to be made at the falls known as Coulter's, Crooked and Rainbow, situated about three miles down the river from Great Falls. At this point the head will be about 105 feet. A crib dam about 25 feet high will be built with masonry head-gate and waste-gate structures. A steel penstock, 22 feet in diameter and about 2500 feet long, will extend from the intake to the power house. The latter will be of masonry construction containing about 30,000 horsepower of wheels and electrical apparatus.

The lower development is about 12 miles below Great Falls. Here the fall is about the same as at the upper development. The dam will be of the same construction as at Rainbow falls, the canal being 500 feet long, and directly below this, the power house. The equipment will be a duplicate of that at the upper development.

A considerable portion of the power developed will be used at the Boston & Montana smelter at Great Falls. The balance will be transmitted to more distant places.

Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

The Automatic Starting of a Motor Driven Centrifugal Pump

Engineers having charge of induction-motor-driven centrifugal pumps know how difficult a matter it is to have the pump started automatically. The writer was once employed in a print and dye mill which obtained its bleachery water from an abandoned clay pit. For the privilege of using this water the company contracted to keep a working pit free of water. This pit was fully a mile and a half from the factory, and to trudge through the clinging clay in a rain storm to start the centrifugal pump in the house on the edge of the pit was certainly disagreeable work. Hence my effort to make that pump start automatically by simply throwing in the oil switch in the engine room.

The difficulties to overcome were these: To form a vacuum before the pump started, to cut out the resistance in the motor line automatically to cause the pump to start fairly slow, and to open the main valve on the delivery pipe before the pump attained too high a speed.

The manner in which this was done is shown in Fig. 1. The shaft coupling was disconnected and changed into a clutch by holding the hood *A*, Fig. 2, to one-half of it. A piece of 1½-inch pipe *B*, the 1-inch pipe *C* and the bolt *D* were then assembled as shown in Fig. 2, *E* and *F* forming the gripping shoes of the clutch. It will be seen that by turning the handle *G*, connected to the cap of the pipe *B*, the block *F* will come in contact with and grip the other half of the coupling connected to the pump shaft. Six of these were used. The bolt *H* prevents the shoe from turning with the handle.

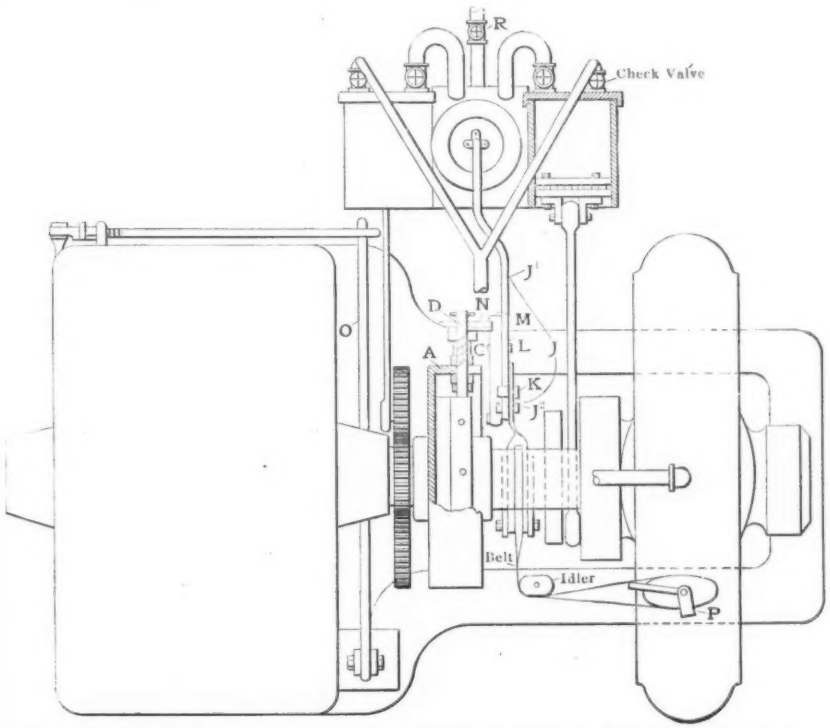


FIG. 1. SHOWING CHANGES THAT WERE MADE TO ENABLE PUMP TO START AUTOMATICALLY BY SIMPLY THROWING OIL SWITCH

To obtain a vacuum, two pumps made of 6-inch pipes with 6-inch strokes were used and driven from the motor shaft by means of suitable gears, as shown in Fig. 1. The crank pins of these pumps were placed diametrically opposite, so that one fills while the other discharges. Regrinding check valves were used on both suction and delivery, and were always kept in good condition. The crank pin of one of the pumps is elongated and fitted with a roller, which slides over the lever *O*. This lever is attached to the resistance-cutting-out lever of the motor, and it will be seen that once in so many revolutions of the motor, depending upon the size of the gear, the resistance will be cut out.

The pumps discharged into a galvanized-iron well, in which was a float made of two buckets soldered face to face. The attached stem connected to lever *J* is jointed, so that the part J^1 moves a certain distance with the rising of the float before it comes in contact with the pin *K* attached to J^2. In Fig. 3 is shown the pin *L* of J^1, which works in a slot cut in the lever *M* which has its fulcrum in the base plate of the pump and stands at an angle of about 45 degrees. It will be seen that *M* is in line with the spokes *G N* of the clutch, and as it is raised by the float it slowly and without jar turns the handles, causing the blocks to grip and the centrifugal pump to start. The rise of the float is governed by opening the valve *R* more or less (Fig. 1).

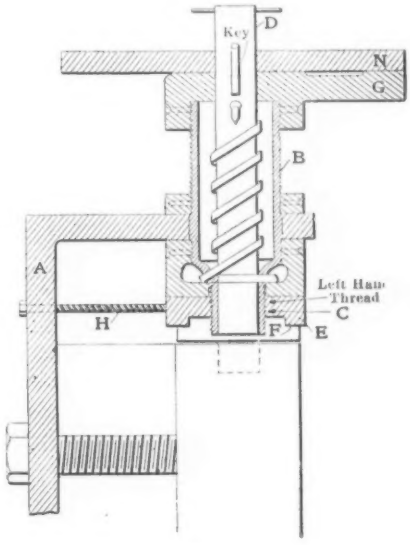


FIG. 2

It is not meant that the tension on the wood blocks *F* should keep the pump running, as they are used only to bring it to a fair speed, so that when the bolts *D* are slipped it will not cause too severe a jar. The bolts are held up by the gib of the keys, one of which is shown in Fig. 2.

One of the spokes in wheel *G* is missing, so that when this comes around opposite lever *M*, as it should do after sufficient tension has been given the clutch

blocks, then wheel *N*, which is a loose fit over the bolt, will be turned until the gib comes opposite a slot. The opening then pulls the bolt down, and sooner or later, depending on the tension given the blocks, it will find the holes bored in the face of the coupling.

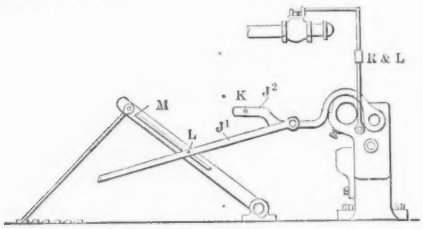


FIG. 3

Thus, so far, by throwing in the main switch in the engine room, the motor starts and the resistance is automatically cut out. The small pumps raise the water for the centrifugal pump, after which it starts. It now remains to open the main gate valve to disconnect the small pumps and to close the valve in their suction line. This is accomplished in the following manner:

When J^1 comes in contact with pin *K* of lever J^2, Fig. 3, a farther rise of the float will now raise J^2. Fig. 3 also shows that this lever holds up the bearing of the gear shaft, and when raised a certain distance will quickly disconnect the two gears, thus stopping the pumps by having the lever of the quick-opening valve on the suction line of the pumps connected to this drop bearing. The valve is closed when the bearing drops. A small belt run over an idler, shown in Fig. 2, from the pump shaft to the pulley of the main valve, will open this valve while the pump turns slowly. When the valve is within two turns of being wide open, the shipper *P*, attached to the moving valve stem, will throw the belt off.

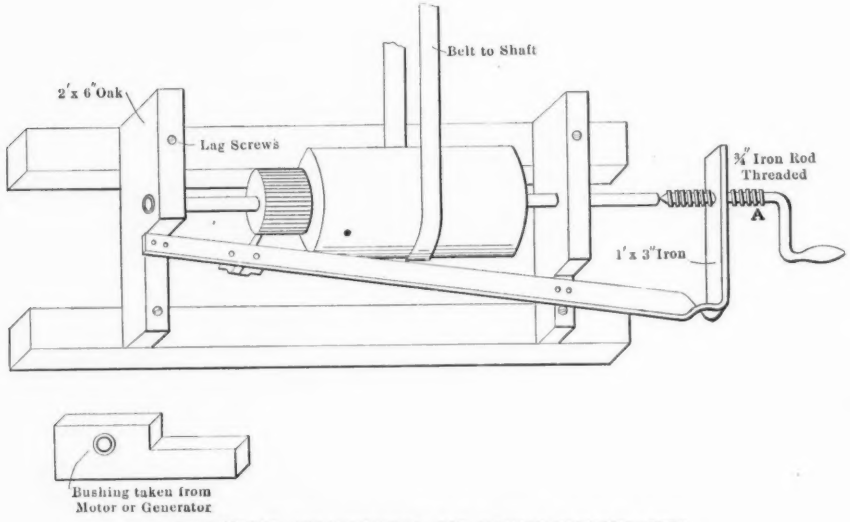
It was the duty of the night watchman to visit the pump house on his way to the mill daily, and he was instructed in the manner of setting the apparatus ready for the next run. To find out when it was required to pump, a small float was placed in the pit and connected to a snap switch, so that when the water raised about 2 inches a lamp burned at the switchboard.

R. O. RICHARDS.

Framingham, Mass.

A Homemade Commutator Truing Device

For the benefit of those having bad commutators and no way to fix them up, I submit the following homemade truing device. When you see that it is impossible to convince the "boss" of the value of having a good lathe, and often your commutator gets in a bad way and you find that he isn't going to do anything, get some good oak 4x6-inch pieces and saw them the length you need for the armature. Bore the cross pieces the correct size for the bushings of your motor and make it pretty snug. Then push the bushing into the hole which you have bored and place the armature shaft in place, taking care that the bushings are placed as much farther apart as the width of the commutator exceeds the total length of the armature core and commutator combined. Then get a good 1-inch piece of 3-inch iron, long enough to make a bend, as shown, and drill it for the bolts which hold the cutting tool, and to fasten it to the cross pieces. A hole is also threaded for a ¾-inch screw, *A*.



HOMEMADE ARRANGEMENT FOR TRUING COMMUTATORS

Secure the piece as shown, so as to move the armature and commutator toward the tool, but be sure to get the piece of iron low enough to be below the center of the commutator. A belt is then run from any convenient shaft over the armature to revolve it while turning down the commutator.

EMERY E. JONES.

Hallsville, W. Va.

[The arrangement described is ingenious and simple, but our readers should bear in mind that its application to armatures on which binding wires are used to hold the coils in the slots would scarcely be advisable, because the driving belt would be likely to loosen the binding wires.—EDITORS.]

Cause of Pound in Engines

In one plant where the engines ran continuously an opportunity was given us to go over everything and take up all lost motion. On starting up, a heavy pound developed on the low-pressure side of the Corliss engine when the crank was on the lower quarter.

The trouble was finally located at the point *A*, Fig. 1. Taking up the brasses by driving in the key on the crank pin brought it low enough to hit the frame at that point, although the pin did not project below the bottom of the gib more than ¼ inch.

Another case of pound showed up in a new cross-compound Corliss engine on the high-pressure side, when the crank was down. In such cases I usually find the cause to be the shaft out of level. In this case, one end was 1/16 inch low, but as it made the crank out less than 1/32 inch it could not be that, especially with bored guides. This engine had tangye frames and oil splashers clear around the crank disks. The pound sounded clearly, as though it was at the crank pin, and yet there were indications that the trouble was in the crosshead.

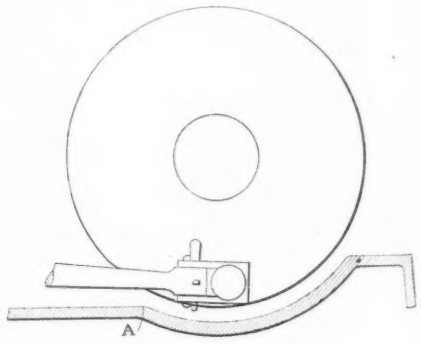


FIG. 1

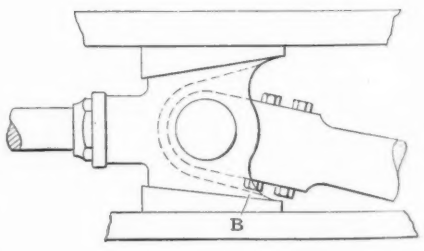


FIG. 2

The end of this rod had a strap held in place by through bolts, but the brasses were set up by wedges. The bolt nearest

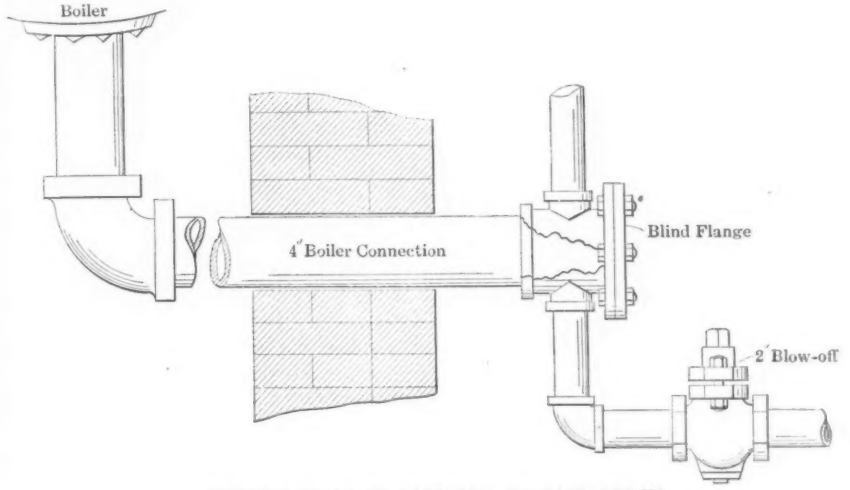
the cylinder was extra long and when the crank was down, the end of the bolt hit the bottom shoe at *B*, as shown in Fig. 2.

W. E. CRANE.

Waterbury, Conn.

Rupture of a Blowoff Fitting

The uncertainty regarding strength of materials and fittings that enter into the construction of steam apparatus was exemplified in the breaking of a cast-iron fitting that had been removed from the blowoff connection of a horizontal return-tubular boiler.



SHOWING BREAK IN CAST-IRON BLOWOFF FITTING

The blowoff piping in question, which is illustrated in the accompanying sketch, was a new job that had been examined by a city boiler inspector for the first time after the boiler to which it was connected had been in service a month or so. The job was condemned by the inspector by reason of the short length of the vertical pipe connecting the shell with the long-sweep ell. This pipe was about 15 inches long, although the depth of the back connection permitted of a drop from the shell of about 30 inches.

The short length of 4-inch pipe dropping from the shell, the horizontal length extending out through the side wall, and the long-sweep ell were all extra heavy. The cross on the outer end of the horizontal length was a second-hand fitting that had previously been in service for a number of years, and had the general appearance of lacking the weight and strength of a standard cast-iron cross of like dimensions.

After screwing the horizontal length out of the long-sweep ell, it was laid across a piece of railroad iron and a few blows of a hammer were given to loosen the hold of the thread and allow the cross to be taken off. At the second blow, the piece of metal indicated by the broken lines in the sketch popped out of the side of the fitting to a hight of two or three inches.

An inspection of the cross revealed a thickness of metal along the line of fracture of a scant ⅜ of an inch. The thickness in the side opposite the fracture was a scant ½ inch; so it was apparent that the fitting had been designed to have a thickness in the walls of 7/16 of an inch, but the core had not been set evenly in the mold.

The steamfitter who had put the original job together evidently had screwed the massive extra-heavy pipe, with its comparatively rigid, unyielding walls, into the frail and uncertain-appearing cross until the stress created therein had just about reached the ultimate strength of the material, leaving practically no factor of safety at all, and it only remained for the shock induced by the vibration of the pipe under the blow of the hammer to complete the work of destruction.

The engineer in charge of the plant had never put this fitting to the test of blowing down under the full boiler pressure of 75 pounds per square inch, and it is more than probable that he was fortunate in not doing so.

The cross under discussion might have had a factor of safety sufficiently high to carry it along indefinitely without rupture, if placed in a steam line where the jar occasioned by the quick closing of a valve would be absorbed in a great measure in the elasticity of the steam; but in the place in which it was located, it is pretty certain that disaster would have resulted from the quick closing of the blowoff cock, and the consequent sudden arrest and impact of the relatively non-elastic water.

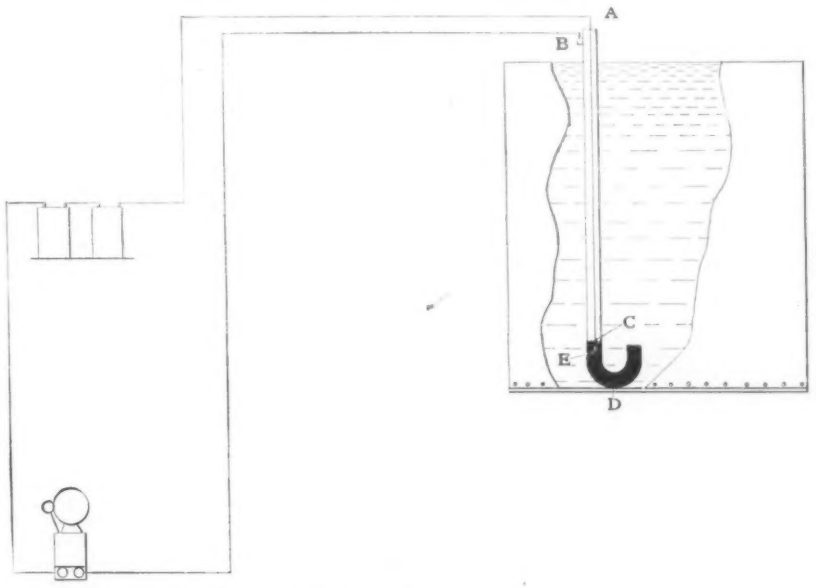
Its use for the particular purpose of a terminal to a blowoff and feed connection, in view of the manifest lack of weight and resultant thinness of walls, is certainly open to censure, to say nothing of the incongruity of using a low-pressure fitting in conjunction with extra-heavy pipe and ell.

H. J. DIXON.

Chicago, Ill.

Telltale for a Tank

The following is a method I have used, and found to be very satisfactory in indicating when a tank is full. It consists of a U-tube, one end being short, the other end being long enough to project above the tank. Enough mercury is then poured into the tube to fill the bend. When the tank is empty, the mercury will rise to the same hight in both ends, because the pressure of the atmosphere is then exerted on the mercury.



TELLTALE FOR A TANK

When there is water in the tank, the mercury will rise in the long tube, since the pressure of the water is greater than that of the air. When the tank is full, an insulated wire *A*, with a small fiber washer at *C*, which prevents the wire touching the sides of the pipe, is lowered until the bared end *E* just touches the

mercury. When it comes in contact with the mercury, a complete circuit is made for another wire *B*, which is connected to the pipe.

The wires are connected to a battery and bell, and when the tank is full the pressure causes the mercury to rise in the long tube until it makes a complete circuit from *E* through the mercury to the pipe and then to the other wire *B*, when the bell will ring. When the tank is not full, there will be no complete circuit and the bell will not ring.

EDWARD O. ERICSON.

Helmetta, N. J.

Requisite Pump Pressure

I have often seen articles dealing with calculations as to the pressure of steam necessary to operate a pump against a certain pressure, and invariably we are told to multiply the area of the plunger by the boiler pressure, or whatever pressure you are pumping against, and divide the result by the area of the steam piston, and the result will be the amount necessary to produce equilibrium, to which it will be necessary to add, say, 10 or 20 per cent. to overcome friction and operate the pump. For instance, with a pump having 100 square inches on the steam end of the pump and 200 square inches on the water end, the plunger in the one contains 20 square inches and the other 10 square inches. The steam pressure being 500 pounds but the pressure against which the pump is working 100 pounds, we have

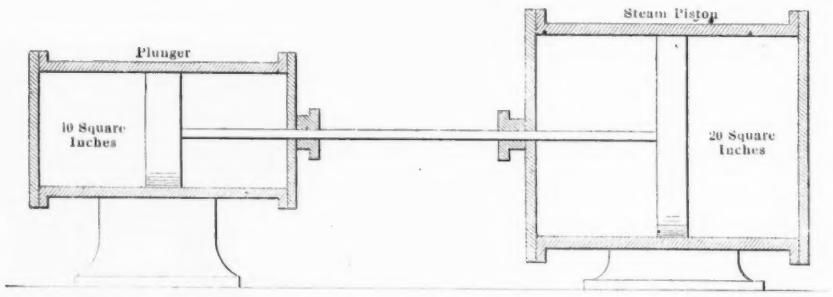
$$100 \times 10 = 1000$$

pounds total pressure, and

$$20 \times 50 = 1000$$

pounds total pressure, hence the pistons are in equilibrium. Add 10 per cent. to this and we have

$$50 \times 10 + 50 = 550$$



WHEN THE PISTONS ARE IN EQUILIBRIUM

pounds necessary to operate the pump.

Taking a case where the 1¼-inch check valve on the feed line has a seat of 1/16 inch, and the 2-inch delivery valve of the pump has a seat of 1/16 inch, and the boiler pressure against which the pump is working is 100 pounds, the pressure necessary to produce equilibrium would be determined by the following:

Area of upper side of check valve, 1⅜ inches in diameter = 1.485 square inches.

Area of under side of check valve, 1¼ inches in diameter = 1.2272 square inches.

$$\frac{100 \times 1.485}{1.2272} = 121 \text{ pounds},$$

the pressure required to put the check in equilibrium.

Area of upper side of delivery valve. 2⅛ inches in diameter = 3.546 square inches.

Area of under side of delivery valve, 2 inches in diameter = 3.1416 square inches.

$$\frac{121 \times 3.546}{3\ 1416} \quad 136.57 \text{ pounds},$$

the pressure required to put delivery valve in equilibrium.

Taking the same dimensions as in the first case, then

$$\frac{\text{area of plunger} \times 136.57}{\text{area of steam piston}} =$$

pressure on steam piston to put the whole in equilibrium or

$$\frac{10 \times 136.57}{20} = 68.18 \text{ pounds}.$$

Now, besides making allowances for friction and accelerating the speed of water to get the required amount, there is one thing which is seldom given a thought and that is the area of both sides of the delivery and check valves.

So that instead of requiring only 50 pounds to put the pump in equilibrium, we require, in this case, 68,29 pounds, and to operate the pump we must still allow a liberal percentage for friction and the acceleration of the water.

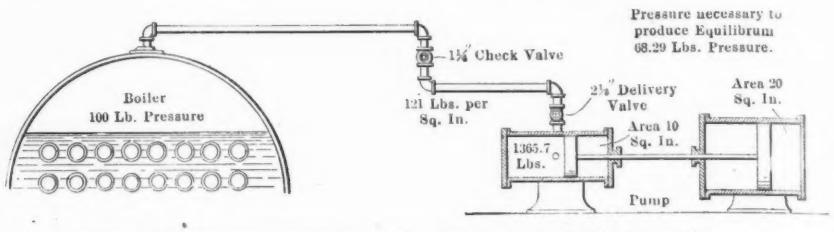
Of course where you get a nearly continuous stream in the feed line the check every stroke they must be taken into acsideration, but as the delivery valves seat every stroke they must be taken into account.

GEORGE H. ANDERSON.

Vancouver, B. C.

The Action of Expanding Steam

In reply to the letter of George P. Pearce, in the issue of September 15, I wish to submit the following simple and plain illustration and explanation:



WHEN CHECK AND DELIVERY VALVES HAVE TO BE RECKONED WITH

The cylinder of a certain engine contains 8 cubic feet; steam is admitted at 100 pounds absolute pressure, and maintained to the point of cutoff, which takes place at one-quarter stroke. What is the absolute, also the gage pressure, at the end of the stroke?

The formula which he submits for the solution of such a problem is as follows:

$$\frac{\text{Initial absolute pressure}}{\text{ratio of expansion}}$$

Applying it to this case gives the following result:

$$\frac{100}{4} = 25$$

pounds absolute, or

$$25 - 15 = 10$$

pounds gage pressure.

The rule which I applied in a previous letter, which he states is incorrect, is herewith stated: Multiply the volume to the point of cutoff, by the pressure, and divide by the final volume. When applied to this case the result is as follows:

$$(8 \div 4) \times 100 \div 8 = 25$$

pounds absolute, or

$$25 - 15 = 10$$

pounds gage pressure.

I am unable to understand how his way can be all right, and mine all wrong, when both give the same result.

He states that the action which I described cannot take place in practice. I supposed that every reader would understand that it was an assumed case, used to illustrate exactly what would take place under stated conditions, which were used to illustrate the point I wished to make plain in order to tell why a steam reservoir was used in this case. It was not my design, but only what I saw in a certain plant.

W. H. WAKEMAN.

New Haven, Conn.

What Wrecked the Engine?

Under the above heading, page 366 of September 1 POWER AND THE ENGINEER, Edward T. Binns describes the wreck of a high-speed engine and asks for an explanation of the cause.

In my opinion the initial rupture occurred in one of the crank-pin box studs, throwing an undue strain upon the other, breaking it also, and thus releasing the reciprocating parts, and as the engine was not heavily loaded, the momentum of the flywheels carried the shaft along for some time, and each reversal of position of the cutoff valve converted the disconnected parts into a heavy and powerful steam hammer. The breaking out of the cylinder head under these conditions is obvious.

The breaking away of the piston-rod nut may be explained by remembering that the front head is reinforced by the engine frame, when called upon to resist strains of this sort, hence the force of the blow due to the inertia of the connecting rod, crosshead and piston rod would come on the piston rod at the piston end; and as the piston is usually secured to the rod by a taper fit and nut, this nut is usually somewhat smaller than that at the crosshead end, hence more likely to strip in a case of this kind.

The breaking of the guide and bending of the connecting rod are explained by the sudden movement of the piston toward the back head, throwing the rod upward as it was being dragged over the end of the guide if it chanced to lie at the bottom of the crank case, and also the probability of its being shot forward and over the crank pin when at the lower part of its travel, and, as the pin rotated, would be forced upward as a lever, to the destruction of all in the way.

It is not always easy to determine the exact order in which events occur in an accident of this sort, but the writer was once the witness of a wreck in which the result was almost precisely similar, and to all appearances the events took place as described.

A 12 by 36-inch Wheelock engine of standard girder frame, running 95 revolutions per minute, broke the strap at the crank-pin end, and the piston then made several strokes, with the connecting rod free, before the head let go.

A large piece was broken from the top guide at the crank end, the connecting rod was bent to an angle of about 45 degrees and the piston split into several pieces. In this case, an old crank, at the point of rupture, eloquently told the story of the cause.

CHARLES L. WARE.

Rockville, Conn.

Vibration of Boilers

For the past year, since installing a new 18x30-inch Corliss engine, we have been troubled with excess vibration of the boilers. Although we have tried most everything that has been suggested, we are still having the same trouble. Our arch wall and side walls show cracks.

The boilers are two of the horizontal return-tubular type, one of 125 horsepower and the other of 65 horsepower.

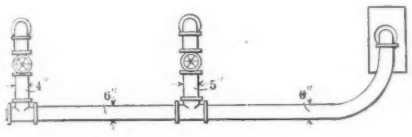


FIG. 1

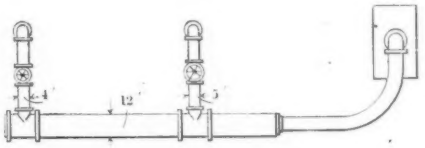


FIG. 2

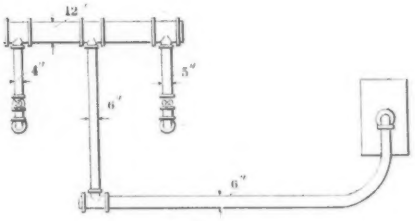


FIG. 3

Our average load is about 225 amperes except for about two hours in the afternoon, when the cupola is put on, which adds about 75 amperes. The engine is direct-connected to a 175-kilowatt alternating-current generator, and runs at 120 revolutions per minute. The engine is situated about 30 feet from the boilers. The original connections are shown in Fig. 1. The pipes had been allowed to swing, being hung from the roof. When this was noticed we put on clamps and drew the pipe up with turnbuckles from both ends. This apparently did not have much effect on the jumping of the boiler. While experimenting with this connection we tried throttling the boiler, which reduced the vibrations to a considerable extent. This method might have served our purpose, but required regulation every day during the time the cupola was running. Also the sharp cutoff of the engine caused the gate in the valve to work back and forth, which quickly wore it out.

Fig. 2 illustrates a 12-inch header which came highly recommended, but did not abate the vibration. Fig. 3 shows a new arrangement, using the same header in a different position. Fig. 4 shows the two pipe leads from the boilers brought up 3 feet over the dome by the use of three 45-degree ells and a 3-inch reducing pipe placed in the leads before it reached the 6-inch main. It was figured that if throttling the boiler had the effect of reducing the vibration this 3-inch pipe might have a useful function. However, it proved to be of no avail.

Fig. 5 shows the last change that has been made which does not correct the trouble. The header was turned parallel with the boilers and the steam pipe had a straight delivery to the engine with the exception of the quarter bend.

RICHARD OWEN.

Racine, Wis.

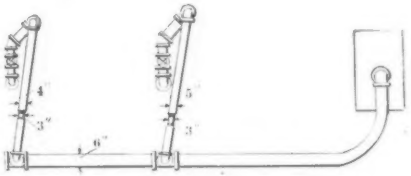


FIG. 4

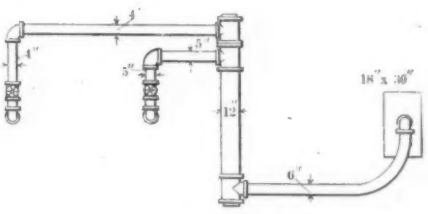


FIG. 5

More Valve Setting Articles Wanted

A subscription agent for another paper was poking fun at POWER AND THE ENGINEER the other day for publishing descriptions of the Putnam and the Greene-Wheelock engines. He said that these engines were so old that they were not made any more, and that POWER must be getting awfully out of date if it could not find anything newer than that to write about.

I told him that the articles were not descriptions of the engines, but directions for setting the valves, and that there was all the more reason for publishing such articles when an engine was no longer made, because you cannot send to the shop for directions. You might just as well say that an article showing how to calculate the strength of a lap-riveted joint is out of date because everybody is talking butt-strapped joints.

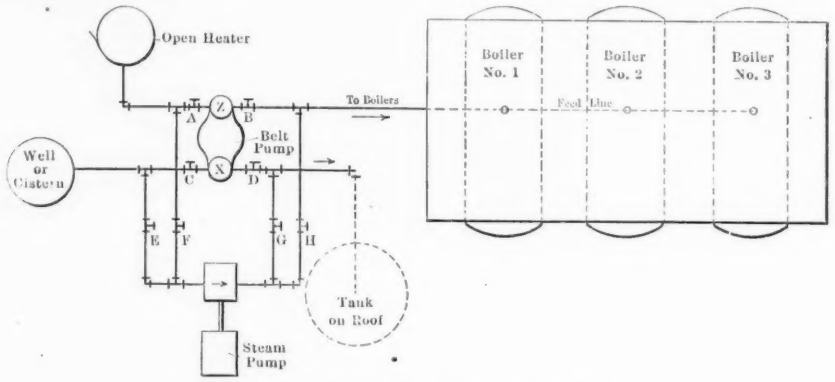
I wish you would have an article on the Cummer engines. They have not been made for years, but lots of us have got them and have got to run them, and keep them adjusted until they wear out.

J. P. ALLEN.

Chicago, Ill.

Feed Water System of a Small Power Plant

The feed-water system of my present plant, which is typical of the common, small power station, connects and operates between four principal points—a well or cistern, a tank on the roof, an open heater and a battery of boilers.



PLAN OF BOILER ROOM AND FEED-WATER SYSTEM

Referring to the illustration, the process is as follows: The plunger *X* of the belt pump, draws cold water from the combined well and cistern and forces it up to the tank on the roof and gravitates back through a pipe, not shown, to the open heater; the regulation of the amount flowing to the heater being automatically governed by a butterfly valve in the pipe and a float in the heater.

From the heater the plunger *Z* takes the hot water and forces it into the boilers. These two plungers have variable strokes and I keep them of such lengths that they will just do their work. Plunger *Z* keeps the water level in the boilers constant and plunger *X* keeps the tank on the roof full.

If there is any virtue in my system it is in the manner in which I have connected my steam pump to the work of the other two. A little study of the plan will make the working plain. In the first place if "all is well," I leave valves *A*, *B*, *C* and *D* open and keep *E*, *F*, *G* and *H* closed, but if plunger *Z* does not hold the water in the boilers because of an extra load, then I open valves *F* and *H* and let the steam pump help out for a while. If something should go wrong with plunger *Z*, I can close valves *A* and *B*, cutting that plunger out entirely and feed the boiler altogether with the steam pump until repairs are made. If plunger *X* is in need of repairs, I open valves *E* and *G* and the steam pump is right "on the job." If plunger *X* is disabled, then by closing valves *C* and *D* it can be cut out and the steam pump again take the place of the disabled side until all is made right. By opening valves *E* and *H*, the steam pump can be made to take water direct from the well and force it into the boilers. By opening the valves *F* and *G* I am able to pump the water in the heater into the tank on the roof.

When a boiler is being washed out it can be filled from the tank on the roof by simply opening the valves *G* and *H* and letting the water gravitate. If the other two boilers are in operation at the time, I pump them up previously and then let the hot water from the plunger *Z* mix with the cold water from the tank and the clean boiler will be filled with lukewarm water before the level in the other two boilers was dropped over 2 or 3 inches.

At night when the plant is shut down, the steam pump is available for any of these services. This means that the steam pump often has to be used for pumping both cold and hot water, and I found that the trouble in getting it to take hold of the well was easily overcome by tapping a small pipe, with a valve, from the line going up to the tank and inserting it in the suction of the steam pump, which made cooling off easy.

I have had considerable trouble with getting a valve that would give good satisfaction on the injection water to the top of the heater. After trying two or three kinds I find that a good butterfly valve connected to the float in the heater, so that no weight will rest on the stem of the valve, gave the best results. All water of condensation that is hot is returned to the bottom of the heater, and all that is cold is returned to the well, from which it comes to us again.

R. Manly Orr.

Brantford, Ont.

Do It Now

I read with much interest the views set forth in the editorial in a recent issue, under the caption, "Do it Now," and can say from my own experience that I have found the proper and only course to follow is to "do it now." An idea possessed by some engineers is that one must not do anything but look after the engine. If he is chief in a large plant, he has his hands full without doing any manual labor, but in a small plant his work would only amount to three or four hours if it were all bunched together.

Some engineers, if they have a breakdown, have to send for a machinist to make repairs and get them started again. He who never does any more than he is paid for never gets paid for any more than he does, and the fear among some engineers of losing dignity is becoming alarming.

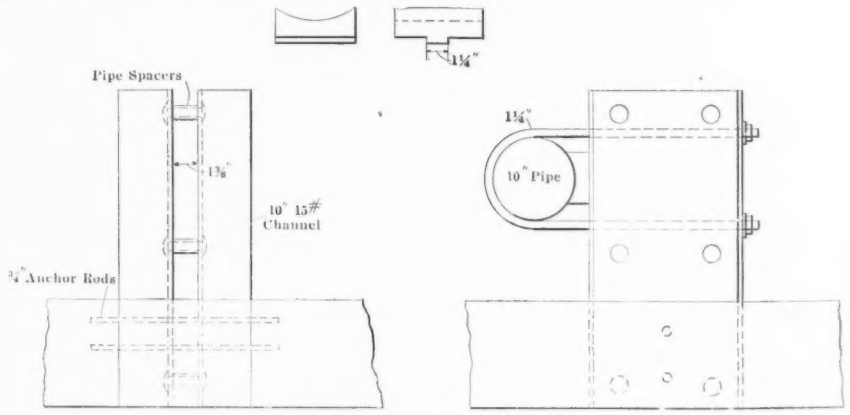
W. B. Archer

Alexandria, Va.

Anchor for Steam Header

The accompanying sketch shows the method of anchoring a steam header to a wall so as to allow expansion in both directions, the anchor being placed as near the middle of the header as possible.

Two 10-inch channels are riveted back to back and separated 1⅜ inches by means of pipe spacers. Two ¾-inch anchor rods are placed through holes drilled for this purpose and the ends of the channels are built into the wall during the construction of the latter.



METHOD OF ANCHORING STEAM HEADER TO WALL

A cast-iron saddle, provided with a tongue 1¼ inches wide, rests on top of the channels, the header (in this case 10 inches) being strapped to the saddle by an 1¼-inch U-bolt passing through the space between the channels, and held against the bottom by the nuts bearing on plate washers.

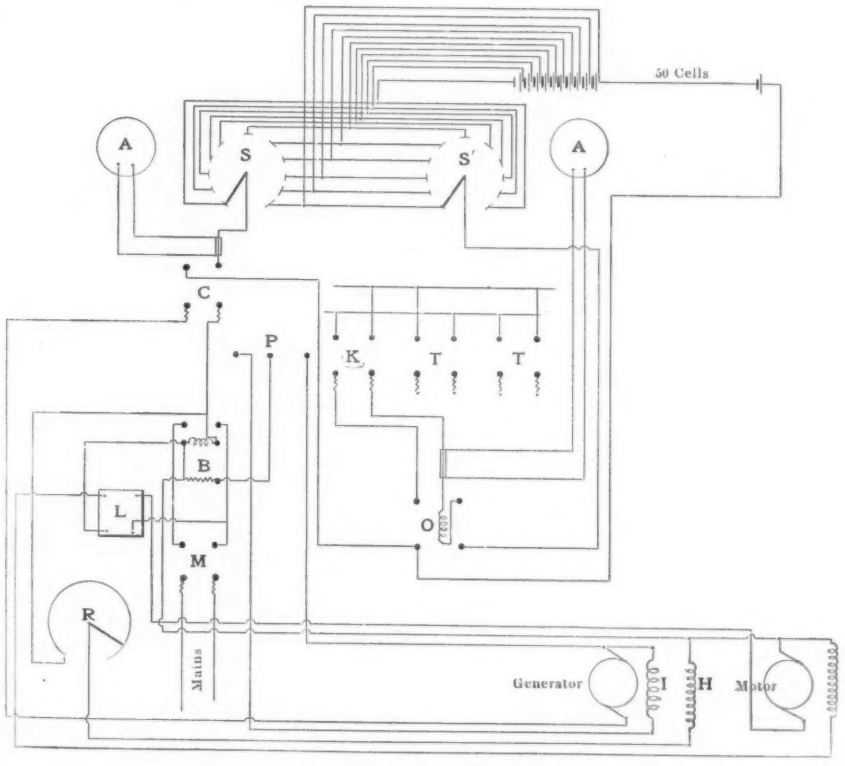
George W. Martin.

Pine Bluff, Ark.

A Low Voltage Electrical System for Signaling

The article by Mr. Saeger in the issue of August 25, on "A Low Voltage Electrical System for Signaling, etc.," has suggested the possibility that he and others might be interested in a system such as is used in operating the delicate instrument known as the telautograph.

The telautograph is extensively used in sea-coast fortifications for the purpose of transmitting data to the guns during action; it is also used for commercial purposes and most electricians are familiar with its principles. It is needless to say that this instrument, in order to transmit writing so that it will be legible, must be supplied by a very steady voltage; a slight fluctuation in voltage is sufficient to distort the writing of the receiver so that it cannot be deciphered.



WIRING DIAGRAM OF TELAUTOGRAPH SYSTEM

At one time it was the custom to operate the telautographs from storage batteries, which also supplied current for lighting and other purposes. This, however, was very unsatisfactory, due principally to the high rise of the battery voltage during charging and to sudden changes of voltage when a load was thrown on or off the battery.

A system has been designed whereby the telautographs are now supplied from an isolated storage battery, so controlled that the rise of voltage during charging is practically overcome, insofar as the proper action of the telautograph is concerned. The system also accomplishes proper regulation while charging is being done from mains in which sudden voltage changes may be quite a serious factor.

The diagram shows the wiring of the system complete to the point where current is distributed to the instruments. The battery consists of 60 cells, 10 of which are end cells connected to the two end-cell switches so that *S* regulates the charge and *S'* the discharge. In this manner, charging and discharging can take place at the same time, so to speak. The battery, however, cannot discharge while charging, it simply regulates the voltage supplied by the discharge side. By regulating the number of end cells in circuit on the discharge side, with the end-cell switch *S'*, the proper voltage can be supplied to the telautographs continuously, and at the same time the battery can be charging with all or part of the end cells in circuit, by regulating with the end-cell switch *S*.

The generator of the booster set has two field windings, a shunt winding *H* and a series winding *I*. The magnetizing effect of *I* counteracts that of the shunt winding, thus producing an electromotive force opposite to that of the line and shunt electromotive force. It will be noted that while charging, all of the current used, both in the charging circuit and by the telautographs, must pass through the series winding of the generator and the electromotive force impressed on this load is greater than that of the 110-volt mains. Any sudden drop in the mains supplying the set which tends to lower the current in the booster will reduce the counter electromotive force produced by the winding *I* and raise the electromotive force of the booster in direct proportion. A steady voltage is thus practically maintained at the battery terminals, eliminating the sudden change of voltage at the telautograph terminals so undesirable in the former system.

Referring to the diagram, *P* is a single-pole double-throw switch which makes it possible to cut out the winding *I* when so desired. The overload- and reverse-current breaker *B* protects the system from overload and also from a drop of voltage in the mains sufficient to reverse the battery. The circuit breaker *O* protects the discharge circuit. At *T T* are two switches supplying the telautograph distributing boards and *K* is the main switch supplying the busbars. The rheostat *R* regulates the voltage of the generator, which is a 2.4-kilowatt machine of 1050 revolutions per minute. At *L* is a starting box in the motor circuit; *C* and *M* are the charging and main-line switches, respectively. The ammeters *A A* are, one each, in the charging and discharging circuits. A swinging voltmeter, not shown in the diagram, is also provided, with a six-point voltmeter switch giving positive to ground, negative to ground, main line, booster, busbar and battery voltages. The battery is a type E-13 Willard, of 240 ampere-hours capacity. The normal voltage used at the telautographs is 110.

RALPH R. GELTZ.

Fort Strong, Mass.

Danger of Imaginary Safety

The writer would like to indorse all Mr. Ranney says in the July 21 number about the "Danger of Imaginary Safety."

It has been my experience that safety water columns, feed-water regulators, and the average engine stop are much better out of service than in.

In one of the large boiler rooms of Boston I found a feed-water regulating outfit, but out of commission.

Upon asking the chief how he liked it, he replied, "very much indeed, when it works." Which seemed to me as saying a great deal in a few words.

If a man knows that it is up to him to look out for these things he will do it if he is the right kind of a man. With the so-called safety devices applied, a man would unconsciously begin to rely on them and some day the device fails and he is in trouble.

Calling at one time on one of the principal engine builders of the eastern States, I noticed an engine stop attached to the shop engine; the superintendent offered to show me how it worked and stepped over to the engineer and gave him the order.

Before the engineer attempted to operate it, however, he carefully loosened the nuts on the gland of the throttle with a wrench.

I did not say anything, but did some thinking.

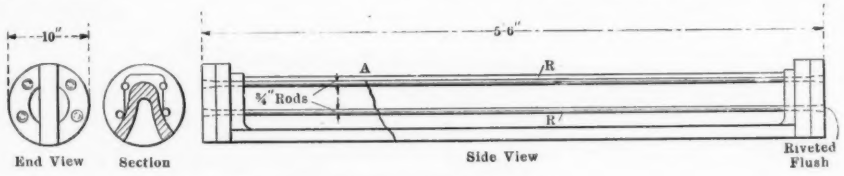
HENRY E. FISCHER.

Boston, Mass.

Repairing a Corliss Valve

G. W. Mellen's method of repairing a broken Corliss valve recalls to mind a similar repair job, but in this case it was the steam valve of the low-pressure cylinder of a 1500-horsepower Corliss engine.

Referring to the sketch, the wavy line *A* shows the location of the break in reference to the slot for the valve stem. The break divided the valve into two parts, and its presence was made known by a knocking in the head end of the steam chest. There was a difference of opinion as to the best method of repairing the valve.



REPAIRING A CORLISS VALVE

The broken parts were clamped together and four ¾-inch round bars *R* were fitted through reamed holes at the end of the valve and riveted flush in holes slightly tapered. The repair was first-class in every respect and the metal fitted into metal at the break. There were no tap bolts to break or nuts to come off, and by so doing twist the valve stem, or get between the cylinder head and piston.

The valve was used for several weeks in this condition until a new valve was obtained from the engine builders, and when the replacement was made the repaired valve showed no signs of weakness.

JOHN I. BAKER.

Allentown, Penn.

Corliss Engine Governor Trouble

Reading the experiences of engineers in the "Practical Letters from Practical Men" columns, reminds me of an experience with a Corliss engine governor.

There had been installed in this locality quite a number of new mills for extracting the cane juice from the sugar cane, and the engines to drive these mills were furnished by a Northern firm.

These engines are connected by heavy gearing to the mill, and in our installation the engine made 15 revolutions to the roller's one, the engine making 40 revolutions per minute, having a bore of 24 inches and a stroke of 54 inches.

The engine was run 23½ hours a day and 7 days a week during the grinding season, which usually lasts 80 days. This, however, has very little to do with the performance of the governor, but is mentioned to show that when once grinding begins there can be no stop, as long as there is a possible chance to keep going. While cane is passing continuously through the mill, the load is very fluctuating, owing to the very irregular feed on the cane carrier, causing, in our case, the governor to race to such an extent that it was necessary for an attendant to stand at the throttle all the time.

It was also noticed that while the engine was running with no load the speed control was all that could be desired. This trouble was experienced by most, if not all, of the installations made that year, and as conditions did not seem to improve any, a man was sent out from the shop to locate the trouble. He explained that the governor was a new type brought out that year, of the top-ball high-speed type. He further explained that no stop had been put on the governor to prevent the sliding collar rising too far, thus allowing the balls to fly out so far that before normal position was assumed the engine would drop considerably below speed; then there would be a few revolutions taking steam full stroke, which again caused the engine to run above normal speed. A stop was put on the governor to prevent this excessive travel of the sliding collar, which was adjusted so that the crab claws caught the steam arms irrespective of speed. This, however, did not help the control of the engine to any perceptible extent, but as this was all the shop man was sent out to do, he then left for the next installation. I hung a cord to the reach-rod arm on the governor to the engine frame and hung a socket wrench to the cord, and by this means managed to run through the grinding season.

The regular speed of an engine of this size would be 65 or 70 revolutions per minute, but as stated, we were only running 40 revolutions per minute. I came to the conclusion that right here was the trouble; the governor having been designed for the higher speed caused the governor to be too sensitive for the speed we were running. There was only one reach rod, which ran from the governor to the top of the first valve, then extending to the bottom of the next valve; thus both valves were actuated by one rod from the governor. Removing the lever on the governor, I put one on that was slotted, allowing the right adjustment to be determined. I, of course, had to wait until the next season to do this as all the machinery is laid by after the grinding season is over.

When a start was made the following season, I commenced my adjustments until I found the right point on the slotted arm, which allowed the engine to run steady, which was determined by the governor not racing. The original length of this lever was 18 inches, and I found that 10 inches was the right length to allow the governor to control the engine. The following year I had a lever made without the slot, in keeping with the rest of the governor.

F. B. DUNNING.

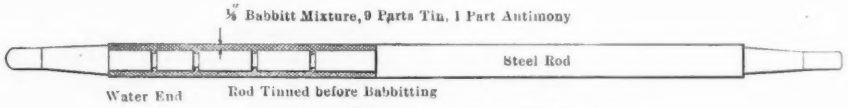
Thibodaux, La.

Wear of Pump Piston Rods

Some pumps when turned out of the factory are equipped with steel rods and serve their purpose well for some localities, but in our particular instance, the water end of the rod gave a great deal of trouble, owing to the amount of sand in the water. At first we tried a copper tubing over the rod, which helped somewhat. We also tried brass or bronze, but did not get the best results.

We finally hit upon the plan shown in the illustration.

We removed the piston rods from the pump and turned them ¼ inch smaller in diameter, cutting four grooves, as shown, 1/16 inch deep, about evenly spaced. A russia-iron casing was then formed ½ inch larger in diameter than the finished size of the rod and about 1 inch longer than the part to be babbitted. The piston rod was then tinned and the russia-iron casing put around it and the one end next to the part not turned was stopped with fireclay. The rod was then babbitted with a mixture of 9 parts tin and 1 part antimony.



METHOD OF BABBITING PUMP PISTON ROD

The rod was then turned down to the proper diameter. In turning we found several blow holes in the babbitt, which were filled with the use of a little solder and a hot soldering iron. After the rod was applied to the pump we were more than pleased with the results.

The babbitt acts, of course, just as badly as the steel or brass tubing, but it saves packing, and there is not a stream of water squirting out at each stroke of the piston. If the packing gets to leaking, it is simply a matter of tightening up the gland.

E. N. OWEN.

Los Angeles, Cal.

The Requisite Qualifications of a Good Gas Engine Operator

The general qualifications which a man should possess in order to be a competent gas-engine runner have been discussed in print and before engineering societies by several writers and speakers. It remained, however, for Henry E. King to formulate what might be termed a set of specifications of what a man should know in order to fill the bill. Mr. King's conception of the requirements, as recently published in *The Gas Engine*, are as follows:

He should know how to read the gas meter.

He should know how to locate an engine so that it would be in a clean, dry and well-lighted place with ample belt centers [shaft separation?] for the main belt and avoidance of crossed belts and mule pulleys; also, how to avoid excessive length of line shafting and the advisability of having the main pulley near the center of the shaft.

He should know that a friction clutch for the main drive saves trouble in starting.

He should see that the foundation is of sufficient size [depth and spread?] to hold the engine properly, and that it is well built.

He should see that the engine is set level and well grouted and evenly drawn down, so there will be no unnecessary strain on the base, as the engine might be so strained that it would be out of line.

When the erecting engineer is erecting the engine, he should watch every move made, and if anything is done that he does not understand he should ask why it was done and remember what he was told. He should watch the pipefitter as the work progresses, and so become familiar with all gas, water, air and oil pipes, in order to be able to make repairs intelligently and quickly if they should ever be required. He should know that it is well to run the piping with as few elbows as possible, especially the exhaust pipe.

He should know how to take the igniter apart, clean it and reassemble it properly; how to insulate it and adjust it so that the movable electrode will work freely and the points will not be hammered with unnecessary vigor by the spring; also, what kind of metal is best for igniter points.

He should know how to adjust the igniter so that it will take the smallest amount of current to ignite the mixture, that is, to have the points close and open as quickly as possible, to avoid wasting the battery and reducing its life.

He should know that the igniter should be timed far enough ahead of center to make the hight [maximum pressure?] of combustion and compression occur at the same time [!].

He should know how to charge the battery cells and renew them when exhausted, how to run the wires of the ignition circuit to avoid dirt and oil and long stretches of wire, and that any kind of battery (wet or dry) should be kept in a cool, dry place.

If a magneto or small generator is used for igniter current, he should know at what speed it should run to give the proper voltage. If the speed is too low there will be missed ignitions, waste of fuel and irregular action of the engine; if too high, it will destroy the points in a short time.

He should know how to keep the magneto or generator clean and free from oil and dirt, and the brushes (if there are any) properly adjusted so the commutator will not wear too fast.

He should know that the main bearing caps should be drawn down very tight in order to cause a very rigid effect at the main bearing; that the liners should be so that the bottom nut can be pulled down tight and the top nut just tight enough so that it will lock it. He should know how to adjust the connecting rod at the crank end; if too tight, it will heat, and if too loose, it will knock; so he should know that liners at this point should be of the proper thickness so that all nuts can be drawn down tight and still not bind the crank pin. He should know that there must be a very close adjustment at the piston end of the connecting rod, but not so close as to cause it to bind. He should examine the piston pin occasionally, and if it is worn out of round, he should know that it is impossible to keep it in proper adjustment.

The inlet valve seldom needs any attention, as the cool air and gas constantly passing over keep it comparatively cool, and this valve will seldom need grinding; but he should understand that strict attention must be paid to the tension of the spring on this valve if atmospherically operated; if it is too tight, it takes too much power to open it and it pounds in closing. If it is opened by suction and the spring is too stiff, it will open late. He should know that the spring should have just enough tension to seat the valve just firmly enough that it will not chatter. He should know that, on account of the extreme heat of the exhaust gases, the exhaust valve will need a great deal of attention; that it should be examined at least once a month, and if there are rough spots on either the valve or seat, he should know how to grind it in so that it will seat perfectly.

The fuel valve will need very little attention, and, as there are several styles, it would be necessary for the engineer to study the particular kind of fuel valve on the engine he has charge of. In this case I speak of the fuel valve on engines provided with the hit-and-miss system of governing.

The engineer should know that the oil for the cylinder and piston should be of rather a high fire test, and as free from carbon as is possible, and that just enough should be fed into the cylinder to lubricate it thoroughly and not so much that it will form carbon in the combustion chamber and exhaust pipes.

He should also know that the outside moving parts of his engine should be lubricated with a good grade of machine oil and that all oil must be kept protected from dust and other impurities. He should also know that some parts of an engine cannot be lubricated with machine oil; for example, the mixing valve on a throttling engine, the exhaust-valve stem and the igniter stem, where a few drops of kerosene are advisable occasionally.

He should realize that there is intense heat in the cylinder, and that most of it is concentrated in the combustion chamber, and that the greatest effect will be on the back end of the piston and on the cylinder head.

The engineer should know that if he runs the engine with the cylinder too cool the piston, expanding so much more than the cylinder, is apt to stick in the bore, so he should know that the water connection should be arranged to have temperature as even as possible, so that the expansion will be evenly distributed.

He should know that it is absolutely necessary to remove the scale that collects on the walls of the water jacket, in order to avoid overheating the cylinder. He should know that this scale can be removed with a solution of muriatic acid, by filling the water jacket with it and allowing it to remain there several hours and then flushing it out with clean water. (If all does not come out the first time, repeat the operation until the jacket is free from scale.)

If circulation tanks are used, he should know that the bottom of the tank should be on a level with the cylinder so that the engine may get the benefit of all the water in the tank, instead of only that part which is above the point where the heat is generated; also that all pipes in the circulating system should be as large as practical and with as few bends as possible, and that if the tank is located above or below the engine there should be a circulating pump. He should know that there should be check and waste cocks in both circulation pipes, close to the tank, so that the engine and pipes may be drained without drawing the water out of the tank; that the upper pipe should enter the tank below the water surface. He should also know that the water jacket and circulation pipes must be drained when the engine is idle, if the temperature of the surrounding atmosphere is likely to drop to or below the freezing point. If water is injected into the exhaust pipe, he should know how much to use, and that the drain from the

exhaust pipe should be of ample size and properly trapped to the sewer.

The engineer should know how to regulate the mixture of gas to obtain the best result; that if the mixture is too lean there will be very slow combustion and the mixture will remain on fire and ignite the incoming charge before the inlet valve closes, causing back-firing, and if the mixture is too rich, some of the gas will pass out through the exhaust valve and there will be missed ignitions, causing an explosive mixture to collect in the exhaust pipe and explode.

He should know that a daily record of the gas consumed is necessary in order to know when the engine uses more gas than usual, if the load has been about the same, and that the reason of any increase should be ascertained instantly, not after a big gas bill comes in at the end of the month.

He should know how to make a brake test of his engine. He may never be called upon to do this, but in these days of competition between engine builders, some very strong guarantees are made, and the engineer should be able to see that the guarantee for his engine is being fulfilled.

The engineer should be a man who will listen to advice given to him by proper authorities. He may know a great deal more than the man who is giving him advice, but he may not know the same things, and if he will listen to the advisor he may be able to add a little more to the knowledge he already has.

In general, the engineer should have knowledge enough so that his employer would consult him when any changes are to be made in the motive power, and he should be able to express his views so that they would be convincing.

Big Steel Stack Erected at Ampere

The improvements to the plant of the Crocker-Wheeler Company, of Ampere, N. J., have reached the stage where work is being started on the new power house, which, when completed, will have a capacity of 4800 boiler horsepower. This entire capacity will not be installed at once. To furnish draft for the boilers temporarily, until the complete plant is installed, the company has just erected a steel stack 72 inches in diameter and 105 feet high, standing 125 feet in the air.

FIG. 2. STACK 72 INCHES IN DIAMETER

FIG. 3. ERECTING STACK IN ONE PIECE

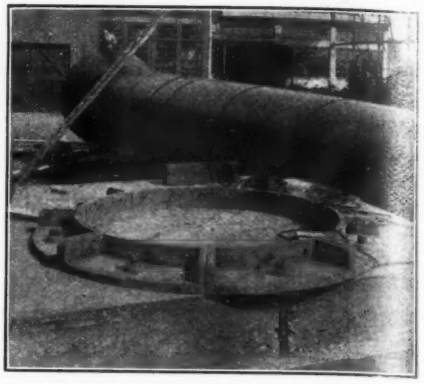


FIG. 1. CAST-IRON SECTIONAL RING SECURING STACK TO FOUNDATION

This stack will supply natural draft to 800 horsepower of water-tube boilers, burning No. 2 buckwheat coal with an ultimate capacity under artificial draft of 1600 horsepower. The boilers are of the modern high-pressure water-tube type (steel castings) for generating steam at 200 pounds pressure. The furnaces of the boilers are each 9 feet 8 inches wide by 10 feet deep. The breeching connection between the stack and the boilers is 6 feet wide and increases in hight as it reaches the stack to provide for future installation of boilers.

The breeching is built of the arched-top and bottom-plate construction to make it self-supporting. The weight of the stack and breeching is approximately 18 to 20 tons, and the stack was hoisted into position in one piece, which attests to progress of engineering construction, as this would have been impossible a few years ago. The present stack is to be used temporarily until further development of the plant, at which time it is contemplated to erect permanent brick chimneys. It is erected on one of the future boiler-setting foundations, which is built of concrete, and that portion on which the base of the stack rests is reinforced with steel. The stack connection to the foundation is provided by means of a cast-iron sectional annular ring which is bolted to the foundation and also to the stack. The stack was designed and erected by the engineering-construction office of Walter Kidde, New York City. It was built by the Dover Boiler Works, of Dover, N. J.

Illinois Heating and Ventilating Engineers

The Illinois chapter of the American Society of Heating and Ventilating Engineers held its annual business meeting and election on Monday evening, October 12. The new officers elected at this meeting are as follows: George Mehring, president; Edmund F. Capron, vice-president; John F. Hale, secretary; August Kehm, treasurer; James Mackay, R. A. Widdecomb and Samuel R. Lewis, board of governors.

Steam Turbines; Flue Gas Analyzing Apparatus

Street Railway Engineers Discuss Piston and Turbine Motors; Conflicting Opinions Based on Experience with the Apparatus

The committee on power generation of the engineering association connected with the American Street Railway Association sent out lists of inquiries regarding the "Practical Operation of Steam Turbines," "Steam Meters" and "Flue Gas Analyzers." The returns were submitted at the recent meeting at Atlantic City. Space limitations require the sacrifice of the questions relating to "Steam Meters," which brought out the least interesting replies.

To the American Street and Interurban Railway Engineering Association:

GENTLEMEN.—Your committee appointed to investigate certain subjects on power generation begs to submit the following report:

Two subjects given particular consideration by this committee were:

The Practical Operation of Steam Turbines.
Flue Gas Analyzers.

At a committee meeting held at Buffalo, June 17, certain questions were prepared which were regarded as essential to submit to member companies and associate members of the association on the subjects under consideration. Each member of the committee present at this meeting was also assigned certain work to be completed before the next and final meeting held in Buffalo August 5, as it was evident from the start that information on flue gas analyzers would be somewhat hard to obtain.

From the total of about 234 inquiries to member companies we received 32 bearing on the subject of Steam Turbines and 14 on the subject of Flue Gas Analyzers.

PRACTICAL OPERATION OF STEAM TURBINES

It was the aim, while investigating this subject, to obtain information as to the relative merits of the two types of prime mover from member companies which have had turbines in operation for some time, and which have also had experience with reciprocating units, in addition to obtaining replies to a few questions applying only to the turbines.

Of the total of 30 questions on the data sheet sent out on this subject we have tabulated for comparison replies on the more important questions asked, so as to give this information in full, as nearly as possible

Of the companies receiving the data sheets, 32 responded in whole or in part. In the compilation of the information thus received, each company replying has been given a distinguishing number which is the same for all of its answers on the subject of steam turbines, thereby enabling one to connect the several answers of any one company. The compilation is as follows:

Mention number of turbine units, rated capacity.	*How long has each been in service?*	*Total capacity of reciprocating units.*
1. 2 1000-kw	6 mo.	530 hp
	1 yr., 5 mo.	
2. 2 1500-kw	3 yr., 6 mo.	800 kw
	1 yr., 6 mo.	
3. 1 1500-kw	2 yr., 6 mo.	2500 kw
1 75-kw		
4. 1 3000-kw	2 mo.	8600 kw
5. 1 500-kw	1 yr., 6 mo.	1300 hp
6. 1 1500-kw	3 yr.	1700 kw
3 300-kw	1 yr., 5 mo.	
7. 1 2000-kw	8 mo.	3850 kw
8. 5 2000-kw	4 yr.	5200 hp
9. 2 1500-kw	2 yr.	
10. 1 500-kw	3 yr.	1200 kw
11. 2 1500-kw	2 yr., 6 mo.	
1 500-kw	3 yr., 7 mo.	1800 kw
12. 2 5000-kw	1 yr.	3500 kw
13. 1 5000-kw	5 mo.	25,400 kw
14. 5 500-kw	3 yr.	
15. 2 1200-kw	2 yr.	
1 3000-kw	6 mo.	30,950 hp
16. 1 400-kw	6 mo.	
1 1000-kw	1 yr.	1000 kw
17. 1 1500-kw	1 yr.	
1 2000-kw	1 yr., 6 mo.	
18. 2 3000-kw	2 yr.	4700 kw
19. 2 1500-kw	8½ mo.	4700 kw
20. 1 1500-kw	1 yr., 6 mo.	250 hp
21. 2 500-kw	4 yr.	
1 1500-kw	1 yr., 8 mo.	3850 kw
22. 2 1000-kw	4 yr., 6 mo.	
	4 yr.	1000 kw
23. 2 1500-kw	1 yr., 6 mo.	2800 kw
24. 2 3500-kw	6 mo.	18,000 hp
25. 2 500-kw, 2 1000-kw	1 yr., 8 mo.	
26. 3 1000-kw		3000 kw
27. 1 500-kw	3 yr.	
1 400-kw, 4 1500-kw	1 yr., 6 mo.	2500 kw
28. 2 1000-kw	3 yr.	
4 25-kw	2 yr.	
3 1500-kw	1 yr.	3000 kw
29. 2 400-kw	4 yr.	
30. 1 2000-kw	3 yr., 5 mo.	1500 kw
31. 2 800-kw	1 to 4 yr.	
1 500-kw		
1 2000-kw		
32. 1 3000-kw	6 mo.	17,450 kw

What is the difference between turbine plant and reciprocating engine plant in fuel consumption per kw-hour under like conditions of load?

1. About 25 per cent. saving with turbine at 50 per cent. load factor, engines at 65 per cent. load factor. Engines not in best condition. Corliss would do better.
2. With high vacuum and variable load the turbines will do from 10 to 20 per cent. better than the engine plant.
3. Have not made any test.
4. Not in operation long enough to determine.
5. Fuel consumption the same in our plant, turbine running condensing under 26 in. vacuum and engine running condensing.
6. No special test records at this time, but general results for above period are in favor of turbines.
8. Turbine about 2.84 lb. Engine about 2.69 lb.
9. In turbine plant total cost of power is about 75 per cent. of cost in cross-compound-condensing Corliss plant built 6 yr. ago, both plants being equipped practically the same, except engine plant has smaller units.
10. About the same.
11. In a well designed plant in favor of turbine.
12. No tests made.
13. About 15 per cent. in favor of turbine.
15. Our experience has been that with good first-class reciprocating engines, condensing economy in operation is approximately the same.

16. They are about the same, taking auxiliaries into consideration.
17. Turbine under similar load about 6 per cent. in favor of engines.
18. About the same.
19. Turbine 19.35 lb. steam per kw-hour. Engine 30.96 lb. steam per kw-hour.
22. Corliss require about 25 per cent. more coal per kw. All depends upon the condition of engines and turbines. Have had tests where turbines required 15 per cent. more coal than the engines, due to dirt on blades.
23. Very little in our case, all conditions being equal as regards vacuum and superheat; taking into account auxiliaries in both cases would favor reciprocating plant.
24. All things being equal we believe there is a slight difference in favor of the turbine.
25. No comparison.
26. Not any.
27. The turbine has an advantage due to high efficiency on a high range of varying load.
28. Engines a little more economical with us.
29. Cannot find any difference.
30. Turbine uses about 10 per cent. more steam than the engine.
32. Practically equal.

	What vacuum are you obtaining under normal operation of your steam turbine?	*Do you inspect your turbine systematically and to what extent and at what intervals?*
1.	26 in. to 27 in. summer	Every 10 months.
2.	27½ in.	Bearings twice a year. Wheels once a year.
3.	26 in.	No, inspect externally every day.
4.	27 in.	Six months.
5.	26 in.	By taking out the intermediate and noting the erosion on blades about every 6 months.
6.	28¾ in. to 29¼ in	One turbine per month, with 4 turbines, 3 times per year.
7.	28 in.	Every 3 months to check clearance.
8.	28½ in.	4 times a year we examine the lower guide and step bearings.
9.	28 in. to 29 in	Lift up top half of case once a year.
10.	27 in.	Give it an internal examination every three months.
11.	28 in.	For wheel clearance every 60 days, valves 2 to 3 times per year.
12.	1 ½ in. to 2 in. above absolute	
13.	27½ in. to 28½ in	Every four months.
14.	27½ in.	
15.	28 in.	Approximately once a year.
16.	27½ in.	Open once every 4 months.
17.	27 in. to 28½ in	Every night by carefully looking over everything and gaging for step bearings.
18.	No.	No.
19.	28.2 in.	Expect to open them once a year. Have not opened either so far.
21.	27 in.	From one to three months.
22.	26½ in. to 27 in	Once every year. Examine all blades and clean all bearings; thoroughly clean blades after running three years.
23.	26 in.	Examine buckets and nozzles twice a year. Step and guides four times a year.
24.	28 in.	No.
25.	27 in. to 28 in	Machines are inspected about every six months.
26.	28 in.	
27.	27 in.	Turbines are opened up for inspection every 6 months and the scale caused by the gland water is removed, and turbine clearance taken.
28.	28 in.	No.
29.	26 in. summer, 28 in. winter	Every 6 months.
30	27¾ in. to 28¾ in	Examine clearance about every 3 months. Inspect blades for wear about once a year.
31.	27 in. to 28 in	Every 3 or 4 months and oftener if possible.
32.	28 in.	We intend to make inspection every 6 months.

	Do you consider it equally necessary for turbines and reciprocating engines to be heated up before starting, and which has advantage in time?	*If not, which has the advantage in time, and how much?*
1.		Same.
2.		Turbine can be started instantly and put to work. Engine should have several minutes.
3.	Yes	Yes, but reciprocating engine has advantage by one-half time of turbine.
4.		Turbine one-half time.
5.		Both the same.
6.	Emergency cases, no; good operation, yes	
7.		Turbine from 5 to 10 minutes.
8.		Both the same.
9.		Both should be thoroughly heated, but think engine could be started in short time with greater safety than turbine.
10.		Both the same.
11.		Yes, but turbines have advantage.
12.		Engines can be started more quickly.
13.		Both the same.
14.		Both the same
15.		
16.		Both the same.
17.	Certainly, but engine has advantage.	
18.		
19.		
21.		Yes, but the turbine has some advantage.
22.		Yes, but it requires a little more time to start turbine because oil must be pumped up first.
23.		Yes, slightly in favor of turbine
24.	Yes.	
25.		
26.	Yes	Turbine half the time.
27.	Yes, particularly turbines.	Engines have advantage.
28.	Yes, engines have advantage.	
29.	Yes	
30.	Yes, easier to start engines than turbines with auxiliaries.	
31.		
32.	Yes	Turbine has advantage in time.

Does your experience indicate that the erosion of turbine blades is going to be a material factor in the maintenance of same?

1. Cannot see any erosion in our blades.
2. At this time cannot state; no perceptible wear.
3. Had no trouble from this source.
4. Not in service long enough.
5. Iron or steel blades, yes; bronze, no.
6. Cannot state what time in service.
7. No.
8. No.
9. No, and particularly if superheated steam is used.
10. It depends on quality of steam. In our case, no.
11. Cannot say; with three years' experience no trouble of that kind has developed.
13. No.
14. No.
15. No.
16. No.
17. No.
18. No.
19. Have not had sufficient experience.
21. No.
22. We have not had any erosion of blades.
23. Not had sufficient time to determine.
24. No.
25. Experience too limited.
26. No.
27. No. We expect to remove several rows the coming October.
28. Not under favorable conditions.
29. No.
30. Not at all serious.
31. No.

Considering the decreased efficiency of the turbine under overload, to what extent is the use of the overload capacity justified in carrying the daily peaks of railway service?

1. Would only figure on 25 per cent. overload for railway peaks.
2. Full overload capacity can be carried on one hour's time to better advantage than putting in another unit.
3. We cannot tell, as we do not have turbine on railway circuit.
4. Use reciprocating engine for peak loads.
5. About 33 per cent.
6. Would carry reasonable overload at peak, but not to invite interruptions.
8. To about 50 per cent. overload.
9. Character of load and station conditions must determine this.
12. Under our conditions, 100 per cent. overload.
13. Twenty-five to 30 per cent.
14. Thirty to 40 per cent. for peak loads of ordinary duration.
15. For suburban practice, 50 per cent. account character of load.
17. I do not consider there is any decreased efficiency on overload.
19. Have not carefully gone into the matter, depends largely on nature and length of peak load.
21. We find the overload capacity more economical than reciprocating units.
22. It is very important with us to have the overload features, as we frequently have an average load of 1100 kw per 1000-kw unit. Load is frequently 100 per cent. over normal.
23. Forty per cent; we find little decrease in economy.
24. We use overload capacity only for breakdown service.
25. We consider the turbine far superior to reciprocating engine to carry a peak on a temporary overload; when an overload of from 50 to 100 per cent. is suddenly encountered it is hardly noticeable to one in the turbine plant.
26. Fifty per cent.
27. Fifty per cent.
29. In plant of this size, fully justified.
30. To the maximum possible extent. But not economy when the peaks slow down the machine from overload.
31. Do not believe in overloading at any time except for emergency.
32. If overload can be carried without starting another unit.

The first three questions were: (a) Mention number of turbine units and rated capacity; (b) how long in service, and (c) capacity of reciprocating units. The replies to these reveal that the period of observation extends in some cases over four years, the average being two years and three months. They show that our replies come from those who have had experience with reciprocating, direct-connected engines and also the older types of belt-driven unit, ranging from 2700 kw down to 200 kw, and with turbines from 5000 kw down to 75 kw, showing a wide range over a satisfactory period of time.

With the above experience with turbine units operating in railway service it is conclusively shown, with very little evidence to the contrary, that the cost of repairs and maintenance and labor cost of operation are favorable to the turbine plant. Such replies as do not confirm this are from one or two cases where apparently the turbine has been operated under some adverse conditions. We have observed that the economy of labor cost of operation of the turbine over the engine is hardly apparent on plants of less than 1000 kw, but on larger plants it seems to be an important factor. In one plant of good size this was given as 0.059 cent for turbines and 0.108 cent for engines. The same plant gave cost of repairs and maintenance as 0.0303 cent for turbines and 0.0407 cent for engines. These comparisons were made where both engines and turbines were of about the same size. They were the only exact figures which our inquiries elicited and, therefore, cannot safely be assumed as typical.

The difference between turbine plant and reciprocating-engine plant in fuel consumption per kw-hour, under like condition of load, has not shown the turbine to possess such a decided advantage. Replies to questions on this subject are more nearly equally divided, but from a number of companies no reply was obtained on account of not having data. However, the evidence seems to be favorable to the turbine.

The reliability of a prime mover in railway operation is one of the essential elements in its service, as a railway unit often has to endure extreme variation in load impressed on it, and at occasional intervals under adverse pressure conditions. Twenty out of 27 replies indicate that they consider the turbine equal to or preferable to the reciprocating engine on the score of reliability, while but 5 prefer reciprocating engines as to this point; 2 replies indicate insufficient length of time to form an opinion. For operation under varying steam pressure, the replies are not so decidedly favorable to the turbine, there being 5 of the 24 replies favoring the reciprocating engine.

Even though the turbine is a much simpler and possibly more reliable unit than the reciprocating type, the importance of high vacuum and superheat necessary to its most economical operation necessarily adds more complicated and less reliable equipment to both boiler and engine room. It is probably on account of this essential auxiliary equipment that a great many replies from users of the turbine are not more favorable to the turbine.

Steam-driven auxiliary equipment is preferred under most all circumstances, and especially so where the exhaust is needed to heat the feed water. From a few replies, engineers preferred electrically driven exciter units and circulating pumps.

The condensers preferred by companies replying were necessarily of various types, as local conditions and quality and quantity of water available govern their choice.

The vacuum as obtained by railway companies operating turbines varies from 26 in. to 28¾ in., and one company reported operating as high as 29 in., and another at 29¼ in.

From 31 replies only nine companies reported that they do not superheat steam.

The questions, "Do you consider it equally necessary for turbine and reciprocating engines to be heated up before starting?" and "Which has the advantage of time?" were asked. It was, we believe, one of the earlier claims that a turbine, on account of its simplicity, could be started much sooner than the reciprocating engine, but replies to the above questions do not prove this, as practically all users of turbines reporting regard it equally

necessary to heat the turbine and a few report favorably to the engine on account of the complicated auxiliary equipment of the turbine.

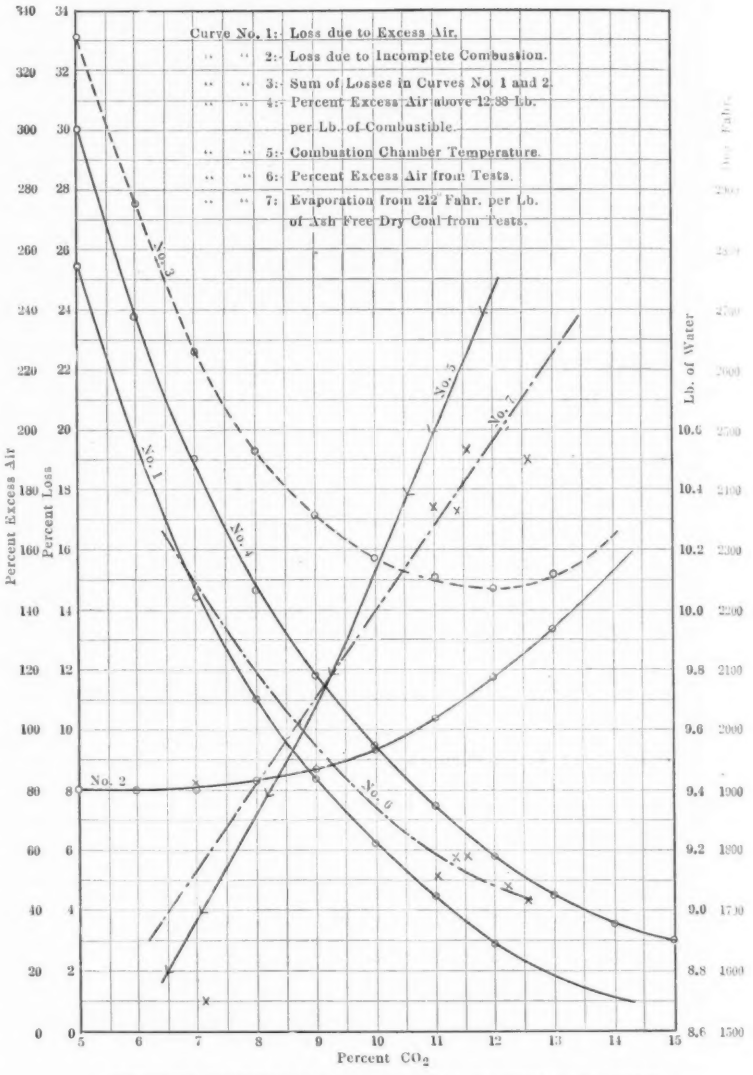
Replies to the questions, "Do you inspect your turbines systematically by opening?" and "To what extent and at what intervals?" the answers are with but three exceptions that they are inspected systematically, but as to the extent of inspection there is a variety of practice. Some inspect externally once each day, while some companies inspect thoroughly, externally and internally, once every three or four months; the internal inspection being for the purpose of examining blade clearance and removing any scale formation.

At one time there was a feeling in some quarters that the erosion of turbine blades and buckets might be a material factor in the maintenance and also affect the economy, but if the experience of those who have replied on these points can be considered as representative of what may be expected, there seems to be little cause for uneasiness on this score. We note that those who have had turbines in use longest report no erosion. It seems necessary, however, to provide proper means for separating entrained moisture from the steam in all cases. One interesting possibility is pointed out in two replies, in the formation of scale on the blades, which is sufficient to affect the economy. It would be interesting to know if this may not have come under the observation of others and what steps might be taken to correct it.

The replies on the question of overload indicate a wide range of practice, it being quite common to take full advantage of the overload possibilities of the units for peak loads as being deemed more economical than starting additional units.

FLUE GAS ANALYZERS

In taking up the subject of flue-gas analyzers, your committee has endeavored to secure such facts in regard to the application and operation of instruments in use as would give a basis for ascertaining their practical value as a part of the usual railway power-station equipment.


Curve No. 1: Loss due to Excess Air.
" " 2: Loss due to Incomplete Combustion.
" " 3: Sum of Losses in Curves No. 1 and 2.
" " 4: Percent Excess Air above 12.88 Lb. per Lb. of Combustible.
" " 5: Combustion Chamber Temperature.
" " 6: Percent Excess Air from Tests.
" " 7: Evaporation from 212° Fahr. per Lb. of Ash Free Dry Coal from Tests.
No. 1
No. 2
No. 3
No. 4
No. 6
No. 7
Percent Excess Air
Percent Loss
Lb. of Water
Percent CO_2

SHOWING GRAPHICALLY HOW SEVERAL FACTORS VARY WITH VARIATION IN PER CENT. OF CO_2

The result of the work we have been able to do indicates that these instruments are of unquestionable value and the records, when properly taken and interpreted, offer a means of detecting defects, both in the construction and operation of boiler furnaces which might not otherwise be exposed. Where only occasional observations are made, the results may be as beneficial as the occasional indication of the steam engine and possibly to a greater degree; and where continuous records are maintained they offer a valuable indication of the character of the fireroom operation. In fact, some prominent engineers go so far as to suggest the practicability of determining accurately the efficiency of the boiler by means of the CO recorder, flue temperatures and coal analysis.

The accompanying diagram shows graphically the general way in which several factors vary with variation in per cent. of CO_2. These facts are : (*a*) the loss due to excess air, (*b*) the loss due to incomplete combustion, (*c*) the variation in furnace temperature, and (*d*) the per cent. of excess air over 12.88 lb. per pound of coal assumed as necessary for perfect combustion. Curves No. 1 and No. 4 are taken from a chart computed by H. J. Westover and appearing in POWER, of April 7, 1908. Curves No. 2 and No. 5 are taken from the report by Prof. L. P. Breckenridge on the St. Louis boiler tests. Curve No. 3 is the combination of No. 1 and No. 2. We appreciate that the curve No. 3 cannot be considered as accurate, and is only given to indicate the general conditions existing and that there is a point in practical operation where further reduction of the air supply may act to decrease the economy.

Theoretically an excess of even a small per cent. of air over that necessary to furnish oxygen for all the combustible should result in no loss by incomplete combustion, but practically it is not possible to secure the thorough distribution of the air necessary to bring this about, and probably curve No. 2 more nearly represents the actual conditions existing. It is proper to point out that no set of curves of this character could be applicable in any specific case on account of the numerous factors which are peculiar to each furnace and kind of coal used. We have also plotted on this chart other data from tests by Prof. Breckenridge at the University of Illinois showing the actual excess air (curve No. 6) and the actual evaporation (curve No. 7), from and at 212° Fahr. per pound of ash-free, dry coal. These two curves are related as being made from the same tests and there were variations between individual tests due to differences in the composition of the coal used, the flue-gas temperatures and other items. They seem, however, to be sufficiently uniform to indicate a definite form and direction, and to corroborate the points we have endeavored to bring out.

A number of questions were sent to the member companies, with, however, but comparatively few replies. Some of these questions and replies we give in tabular form and others are covered in our comments.

In the compilation which follows, showing the experience of various companies with flue-gas analyzers, the companies replying have been designated by specific numbers which do not, however, correspond to the serial numbers indicating the companies in the compilations previously shown on the subject of "Steam Turbines."

Data on Experience With Flue Gas Analyzers

	What Type of CO_2 Analyzer Have You?	*How Long in Service?*
1	Sarco.	One month.
2	4 Sarco recorders. 1 Sarco indicator.	Recorder 2 years. Indicator 6 months.
3	Ados.	Two years.
4	Sarco recorder.	16 months.
5	Orsat.	21 months.
6	Sarco.	3 months.
7	Uehling composimeter.	One year.
8	Uehling.	6 months.
9	Jones-Julia and Orsat.	Number of years.
10	Sarco.	60 days.
11	Sarco.	9 months.
12	Sarco.	One year.
13	Ados.	Two years.
14	Ados.	Two years.

	What are Capacity and Average Load on Boilers, in Boiler Horsepower? Total.	Average Load.	*Do You Use Mechanical Draft?*
1	8,000	7,500	No.
2	50,000	20,000	No.
3	2,000	1,800	No.
4	16,000	8,000	No.
5	13,000	4,000	No.
6	6,500	7,000	No.
7	40,000	....	No.
8	100	....	No.
9	2,450	1,000	Yes—partially.
10	19,200	....	No.
11	5,600	....	No.
12	....	....	Yes, when crowded.
13	10,000	5,000	No.
14	....	11,000	Yes.

	Do You Use Hand Firing or Stokers?	*Do You Find a Daily Correspondence Between High CO_2 and Low Coal Consumption per Kw-Hour?*
1	Murphy & Roney stokers and hand firing.	——
2	Roney stokers 65 per cent. and hand firing 35 per cent.	——
3	Hand firing.	Yes, when recorder is operating properly.
4	Roney stokers.	No.
5	Roney stokers.	——
6	Murphy and model chain grates.	Have not as yet tested this out.
7	B. & W. chain grates.	Yes.
8	Hand firing.	——
9	Chain grates.	No record.
10	Chain grates.	——
11	Chain grates.	Yes.
12	Hand firing.	Not been able to detect.
13	Ross stokers.	Yes.
14	Hand firing to limited extent and Jones stokers.	No.

	What Average Per Cent. CO_2 Do You Usually Obtain Using Recorder?	*What Per Cent. Did You Obtain Prior to Using Recorder?*
1	7 per cent.	——
2	——	——
3	12 to 14 per cent.	About 7 per cent.
4	11 per cent.	4 to 6 per cent.
5	8 to 10 per cent.	4 to 8 per cent.
6	——	7 per cent.
7	9 to 9.5 per cent.	7 to 8 per cent.
8	12 per cent.	11 per cent.
9	10 to 13 per cent.	8 per cent.
10	——	——
11	7 to 8.5 per cent.	——
12	12 per cent.	6 to 8 per cent.
13	10 per cent.	About 8 per cent.
14	9 per cent.	——

	Do You Find Loss on Account of Insufficient Air or Excess Air?	*Do You Make Coal Analysis? If So, What is the Analysis of Coal Used?*
1	Excess.	Yes, 12,000 B.t.u., moisture 3 per cent., ash 11 per cent.
2	Excess.	Yes, abt. 14,000 B.t.u. per lb., 4 per cent. moisture—6.5 per cent. ash, 75 per cent. fixed carbon, 18.5 per cent. volatile.
3	Greater loss seemed to be from excess air. Hand dampers were open only about 50 per cent. area after recorder was in use, without reducing capacity.	No—⅔ Clearfield M/R approximate B.t.u. 13,500 to 14,000 ⅓ semi-anthracite screenings, approximate B.t.u. 9,000 to 11,000.
4	Excess air.	Yes, 14,200 B.t.u.—8 per cent. ash, 2 per cent. moisture.
5	Excess air through holes in fire.	Yes, 12,800 B.t.u. average moisture 4 per cent., ash 10 per cent.
7	Excess air.	Yes, B.t.u. 10,200—moisture 14 to 17 per cent., ash 14 to 20 per cent.
8	Excess of air	Yes, B.t.u. comm. 11,388, moisture 4.59 per cent., ash 17.97 per cent., average for 6 mos. No. 2 Buck.
9	First excessive air. Second, an irregular fire bed Third, insufficient air.	Moisture, 250. Volatile matter, 40.50. Fixed carbon, 48.45. Ash, 8.55.
10	——	——
11	Excess air.	Yes.
12	Insufficient air through fire, excess air by infiltration.	12,000 B.t.u. ash 18 to 19 per cent.
13	Excess air.	Moisture, 1.78 per cent.; volatile, 30.27 per cent.; fixed carbon, 54.32; sulphur, 1.65; ash, 11.98.
14	All causes.	12,600 B.t.u.; moisture, 6.5 per cent.; ash, 11 per cent.; volatile, 29 per cent.; fixed carbon, 55 per cent; sulphur, 1.5 per cent.

	Has the Maintenance and Attention Required to Keep CO Recorder in Service and Operating Accurately Been a Material Factor, and If So, What Expense?	*If Excessive Attention Has Been Required Has It Been Due to Structural Defects of the Instrument or Lack of Proper Skilled Attention?*
1	No.	——
2	Very difficult to keep in operating condition.	Principally acct. instrument itself.
3	No.	Principal attention required is in preventing and repairing air leaks in connections.

4—No, slight.
5— ——
6—No expense.
7—Required some time from a technical person, no factor in expense.
8—No.
9—No material expense.
10— ——
11—Young man who samples coal attends.
12—No expense, attention trifling.
13—Practically nothing.
14—$2.00 per month per recorder.

Where Several Furnaces Discharge Their Gas Into One Stack, Is It Necessary to Have a Continuous Record of Each Furnace, or Will Not a Record of the Stack Gas Used Give All the Information That Is Usually Required?

1—Separate stack.
2—Continuous record on stack.
3—Record of each furnace is best, but good general idea can be gotten from gases taken from stack or fuel.
4—Continuous record for each furnace seemed best, but with experience not necessary.
5— ——
6—We have individual stacks.
7—Record of each furnace is best as it indicates just where low CO_2 is.
8— ——
9—Each battery.
10— ——
11— ——
12—Not for individual boilers, separate records necessary.
13—Record of individual banks of boilers are kept.
14—Each boiler.

In the Event of Finding That Recorder Indicates Unsatisfactory Conditions, What Steps Have You Taken to Improve Results?

1—Stop leaks.
2— ——
3—Clean soot from gas connections pipes and stop air leaks if any. Also stop any air leaks through boiler settings.
4—Watch condition of fires, coal and boiler settings.
5—Improve fire, using care to stop holes.
6—Stopped air leaks in settings and maintained better fires.
7—Experimenting with different methods of firing; fire thicknesses, grate speed, etc.; change in furnace settings, overhauling stokers; eliminating leaks in settings.
8—Regulate air supply. Generally too much air will cause most of trouble.
9—Look for irregular fires. See if draft over fire is good. To correct thick fires and regulate air supply under grates.
10— ——
11—Watch fire closer give usual attention more often.
12—Showed more air necessary for anthracite buckwheat; and large infiltration.
13—Investigate cause and proceed accordingly.
14—See some treatise on combustion.

Do You Find That Your Dampers Require Much More Frequent Regulation Than Before the Installation of the CO_2 Recorder?

1—Have not observed any.
2—Indicators on each boiler.
3—Hand damper should be given more attention.
4—Not since operators have become accustomed to proper appearance of fires.
5— ——
6— ——
7—Very little more.
8—We use an automatic damper.
9— ——
10— ——
11—Yes. Draft gages and damper easy to adjust are valuable.
12—No.
13—Yes.
14—No.

Can Conditions of Firing Be So Regulated as to Give Good Results with High Per Cent. of CO_2 in Flue Gases from Only a Frequent Analysis? Or Do You Regard It Essential That to Obtain Best Results a CO_2 Recorder Should Be Constantly Indicating the Per Cent. of CO_2 in Flue Gases?

1—Yes.
2— ——
3—Most satisfactory information can be gotten from constantly indicating apparatus.
4—Constantly indicating seems best.
5—Either method is satisfactory, but a continuous record is obviously better.
6— ——
7—Best results obtained with constantly indicating and recording instrument.
8—Record should be continuous.
9—Record should be continuous.
10— ——
11—Continuous methods good to teach firemen; afterward an average for the day should keep him up.
12—Have not been able to make any improvements by method of firing.
13—Continuous record necessary.
14— ——

Should Such Record Be So Displayed That Boiler Room Attendants Can See and Be Guided by It? Yes, 14; no reply, 2.

In but one case were we able to secure data showing any definite results as to coal per kw-hour before and after using the recorder. This showed a reduction from 4 lb. to 3.5 lb. per kw-hour, and from other comments it seems evident that the use of it has generally been considered beneficial. In two cases the coal since using the recorder was given as 29.2 lb. and 2.9 lb. kw-hour.

While many improvements have been made in the design and construction of these instruments in the past few years, and while the reports do not indicate that the maintenance is a serious item, nevertheless it is hoped that further effort will be made on the part of the manufacturers to simplify them and make them less a laboratory instrument, so that they will feel more at home in the fireroom.

In order to get the most accurate indication of the action of the furnace itself, the gas collector should be as near as possible in the line of circulation to the point where combustion ceases. Tests should be made occasionally of the gas at this point to check against the record taken from the flue to indicate the air leakage, if any, between these points. The location for the collector usually seems to be preferred in the flue between the damper and the boiler tubes and placed so as to be in a flow of gas of average quality. The gas collector which seems to give best results is of $\frac{3}{4}$-in. or 1-in. pipe with $\frac{1}{8}$-in. holes bored at frequent intervals throughout its length, and the end capped. Care should be taken that the total area of all the holes is less than the area of the pipe, otherwise more gas will be taken through the holes near the exit than through those at the outer end.

The consensus of opinion seems to be that the best results can be secured with a recording analyzer in the main flue, suplpemented by an indicating instrument connected into the breeching of each boiler and the instrument placed so that the firemen can easily see the indication of each boiler.

It had been suggested to us that in order to improve the economy of a plant it would be a feasible plan to pay a bonus to firemen based on the CO_2 record, but we were not able to find anyone who had actually tried this out. One reply indicated that they encouraged their men to get good records by a system of promotion.

It is easier to maintain a high CO_2 record with stoker than with hand firing owing to the unnecessary air admitted through the doors when stoking. The most common error in method of operation of furnaces, which the recorder shows, is the admission of too much excess air, and by watching the recorder and regulating the air supply or condition of the fire more frequently, a higher economy of operation may be secured.

In one reply only was the opinion expressed that a record of other gases than CO_2 was desirable as far as ordinary operation is concerned. It can be imagined that for an exhaustive test on a boiler or on a particular coal it might be desirable to have a record of CO and O, but in ordinary operation it is felt that the record of CO_2 gives all the information that is necessary to secure a high economy. Only three replies indicated that the recorders were regularly tested. This should undoubtedly be done, as there is possibility of errors due to condition of receiving pipes, as well as in the solutions used and the instrument itself.

Recommendations for Future Work

The investigations of your committee have brought forcibly to its attention the apparently indifferent methods of operation practiced in many power stations, and particularly in the boiler room. We believe that there is far too little attention given to economy in the boiler room and think that a careful and systematic use of apparatus available would result in a great saving.

We believe that the work of a Committee on Power Generation should be continued, and that further reports should be expected next year on the subject of CO_2 recorders in addition to an investigation into the use and merits of draft gages, pyrometers and systems of damper control. We also think that an investigation as to the merit of buying coal on a basis of analysis should at some date receive attention by such a committee, together with an investigation as to methods of making analytical tests of coal and the use of calorimeters.

Catechism of Electricity

818. *What, in general, governs the direction of rotation of direct-current motors?*

The relation between the direction of current flow in the armature conductors and the direction of the magnetic flux across the air gaps between the armature core and the field-magnet pole faces. With the field magnet excited the same way, reversing the direction of the current through the armature will reverse the direction of rotation. If, instead of

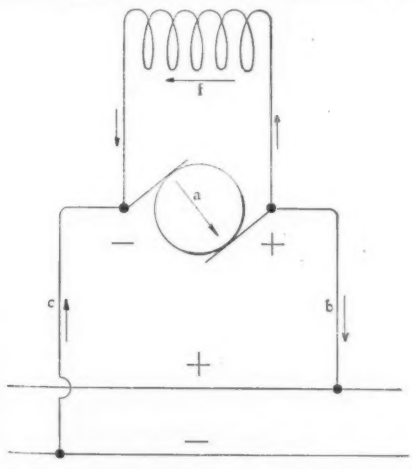


FIG. 270. CURRENT FLOW IN A SHUNT-WOUND MACHINE OPERATING AS A DYNAMO

reversing the current in the armature circuit, the polarity of the field magnets be reversed and the current passed through the armature in the same direction as before, the rotation of the armature will be reversed.

819. *Can direct-current dynamos be operated as motors?*

They can, and in almost all cases without any change. With some special machines a slight change in the connections of its windings is necessary.

820. *How will a series-wound dynamo behave if run as a motor?*

If connected in circuit without any change in its own connections, the armature will revolve in the opposite direction to that in which it would be driven as a generator.

821. *Why is this so?*

The counter-electromotive force developed in the armature of a motor is always such as to oppose the flow of current through it. If the current passes through the windings of the machine in the same direction as when driven as a dynamo, the polarity of the field will remain the same, and the armature must revolve in the opposite direction, running as a motor, in order that it may generate an electromotive force which will oppose the flow of current.

822. *What will happen if the current be passed through the machine in the opposite direction to the normal?*

The armature will revolve in the opposite direction to that when run as a dynamo, because the polarity of the field will be reversed and the armature current is also reversed.

823. *How can a series-wound dynamo be run as a motor in the same direction that it had when run as a dynamo?*

By reversing the connections leading to either the field winding or the brushes, thereby reversing the relation between the polarity of the field and the flow of current in the armature winding.

824. *How does a shunt-wound dynamo behave when run as a motor?*

It will run in the same direction as when driven as a dynamo, because if the current passes through the armature in the same direction as before, it will be reversed in the field winding.

825. *Suppose the current be passed through the armature in the opposite direction to that when running as a dynamo?*

Then the polarity of the field magnet will be the same as when running as a dynamo and in order that the counter-electromotive force in the armature may oppose that applied, the direction of rotation must remain the same as before.

826. *Why is the current through the field winding reversed when the armature current remains unchanged, in changing from dynamo to motor?*

Reference to Figs. 270 and 271 will make this clear. In the former diagram the machine is represented as a dynamo, and the current leaving its positive brush divides, part going to the outer circuit and a small part through the field winding in the direction indicated by the arrow *f*. In Fig. 270 the machine is operating

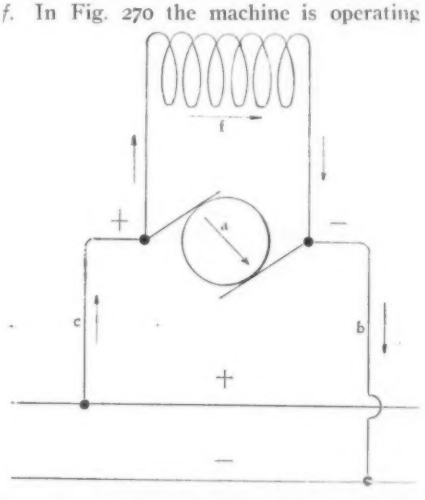


FIG. 271. CURRENT FLOW IN A SHUNT-WOUND MACHINE OPERATING AS A MOTOR

as a motor, and since the armature *receives* current from the line instead of *supplying* it, the leads *b* and *c* must be transposed in order to have the current go through the armature in the same direction as before. The current from the positive main wire follows the lead *c* to the brush and divides there, most of it going through the armature and a little through the field winding. The polarities of the brushes are reversed by the transposition of the leads *b* and *c* and, consequently, the direction of flow through the field winding is reversed.

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

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Contents

	PAGE
Power for a Large Manufacturing Works	681
An Engine Wreck at Dayton	687
Determining the Capacity of a Power Pump	688
Furnace Construction	690
The Plunger Hydraulic Elevator	691
Diagram for Determining Piston and Crank Relations	693
A Few Principles of Oil Separation	693
A Large Suction Gas Producer Power Plant	694
The Parallelograms of Forces	697
Practical Letters from Practical Men: The Automatic Starting of a Motor Driven Centrifugal Pump....A Homemade Commutator Truing Device....Cause of Pound in Engines....Rupture of a Blowoff Fitting....Telltale for a Tank....Requisite Pump Pressure....The Action of Expanding Steam....What Wrecked the Engine?....Vibration of Boilers....More Valve Setting Articles Wanted....Feed Water System of a Small Power Plant....Do It Now....Anchor for Steam Header....A Low Voltage Electrical System for Signaling....Danger of Imaginary Safety....Repairing a Corliss Valve....Corliss Engine Governor Trouble....Wear of Pump Piston Rods	699-706
The Requisite Qualifications of a Good Gas Engine Operator	707
Big Steel Stack Erected at Ampere	708
Steam Turbines: The Gas Analyzing Apparatus	709
Catechism of Electricity	715
Editorials	716-717

Qualifications of a Gas Engineer

On page 707 we present the ideas of an experienced mechanical engineer as to what a man should know in order to be a good operator of gas engines. When it is remembered that Mr. King has reference to the everyday single-acting engine usually operated on illuminating gas, it will be obvious that his ideals are high. If we had originated these "specifications" for a gas engineer, we feel quite sure that we would have been considered exacting, if not unreasonable. However, with the exception, possibly, of the stipulations that the operating engineer should be a foundation expert and an authority on igniter points, Mr. King's requirements are by no means excessive. An engineer who could not measure up to them and, in addition, take indicator diagrams properly and analyze them, would not be fit to be given responsible charge of a gas engine of, say, twenty-five horsepower or more.

While the list of *desiderata* seems rather long, considered as a list, it really is not so formidable after all. Condensed into fundamentals it means merely that a man should understand the general care of machinery; the elementary principles of pipe fitting; the care of an ignition system and the proper timing of ignition; the peculiarities of gas-engine valves and lubrication; the object of water circulation; the adjustment of the mixture for best results; and the testing of the engine. Of these seven requirements, only four are peculiar to the care of a gas engine; the other three apply as well to a steam engineer.

Consider for a moment the parallel qualifications which a responsible steam engineer should have. He must understand how to set valves for best results; the principles of three types of condensing apparatus; the proper lubrication of the cylinders; and what the unintentional condensation of steam in the various parts of the system entails. The first of these alone is far more difficult than all four of the requirements peculiar to gas-engine operation.

The Engine Tender and the Engineer

An engine which had run for years without exhibiting any particular signs of distress suddenly began to heat in the main bearing. The attendant, with all the instincts of the engine tender, hustled about with extra lubricants and lines of hose, intent upon getting the bearing cool and keeping the engine running. Like an empirical physician, he confined his attention and his efforts to doctoring the symptoms with applications which in his experience had overcome such manifestations before. He was very busy with his hands, but his brain, if it worked, was busy only in an unsystematic effort to conjure up some other thing to do.

There enters a man, who, like the real physician, regards the symptom only as the indication of a cause, and sets to work to reason from the effect back to the real seat of the trouble. The bearing always had run all right. There must be some reason for its present distress. There has been no interruption in the supply of lubricant, there is no indication of grit in the bearing and no reason why there should be any. Is it in line? As his eye follows along the main shaft he notices a very perceptible wink. He orders the engine shut down and inspection reveals a fracture which is distorting the shaft in the bearing and causing the signal of distress. Gallons of oil and ponds of water would never have cured the trouble, and a serious breakdown would have undoubtedly resulted if the efforts of the attendant to keep the engine in motion had been successful.

This is the difference between the engine tender and the engineer; that the one knows how to do the things that he has learned—in an emergency to grope and feel and cut and try—while the real engineer, with a broad knowledge of the principles involved, uses his brain instead of, or in connection with, his hands, reasons from effect to cause, and proceeds intelligently to a radical solution of the difficulty.

Concerning Anonymous Communications

Correspondents should be sure to give their names and addresses when sending communications to the editor. It is self-evident that a reply, by mail or otherwise, cannot be made to an anonymous letter, and while hundreds of such are received it is considered that in the great majority of instances it is a case of oversight on the part of the writer, rather than an attempt to conceal his identity. Nothing ever appears in the columns of POWER AND THE ENGINEER of which a contributor need be ashamed. If for any reason a writer does not wish to be known as the author of a published letter or article, a *nom de plume* may be used, but the publisher must know to whom he is giving the use of his columns.

Neglect on the part of an author to give name and address has prevented the publication of much that is excellent, as steam-engineering literature goes, and has hindered many an engineer in his quest for a different or a higher position; for, aside from the fact that a letter of inquiry cannot be answered when the only clue to the identity of the writer is the name of the city or town from which the letter is mailed, ignorance of the identity of the writer not infrequently prevents

the bringing together of the engineer and the manufacturer when a meeting would result in mutual benefit.

There should be no lack of confidence on the part of a correspondent, because no publisher of repute will reveal his name or address without permission. Therefore, it cannot be too strongly emphasized that all letters and manuscripts contributed must bear the bona fide signatures of the writers to receive any attention or consideration whatever.

Periodical Reduction of Boiler Pressure

In this country alone, within the last twenty years, more than ten thousand boilers have been blown to pieces, resulting in the death of more than ten thousand persons, the injury of more than twenty thousand, and almost inestimable property loss. Boiler insurance, necessitating inspection at stated intervals, and the efforts of State or city inspector have been effective in reducing the number of explosions, but even with the improvements in design and better methods of operation required by the inspectors, there is still danger, and boiler explosions are much more numerous than there is really any reason for.

To accuse inspectors of carelessness, wanton neglect, or of susceptibility to bribery, would not be at all fair or just to these men, who in the great majority of cases are competent and adhere strictly to duty. Any visible defect, such as corrosion, a cracked plate or a broken stay, would almost invariably be detected and the boiler be put out of commission, or operated at a lower working pressure, until repairs were made. Evidently it is not the visible defects to which boiler explosions must be attributed; rather, the invisible imperfections, such as faulty riveting, granulation of the metal and deterioration incident to long service.

That it is good practice to assume a large factor of safety for new boilers to allow for wear and tear and possible defects in the construction, or in the metal, is a point universally conceded by engineers and considered of the utmost importance in boiler design. Is it not just as important, or even of greater importance, to maintain this factor of safety in a boiler through its years of service? It is hardly probable that the metal in a boiler is as strong after a continued service of years as it was in the beginning. Deterioration is more than likely to occur, but to what extent depends largely on the service and the care the boiler has had.

To judge the degree of impairment in a boiler at the end of any given time is difficult, and especially so when it is caused by the gradual and indeterminate changes due to successive strains and the action of heat in the structure of the metal itself. It is here that the inspector is liable to err in judgment. There is no set rule to guide him, and unless there is unquestionable evidence to the contrary, reductions in pressure will be made sparingly, or perhaps not at all. It is not uncommon to find boilers that have been in service from fifteen to twenty years still operating under the pressure for which they were originally designed. In such a case it is almost a certainty that the factor of safety has not been maintained.

To eliminate this uncertainty, it has been suggested that a periodic reduction of pressure, to be fixed by law and perhaps varied to conform with the service, be imposed on boilers. It would, of course, be difficult to determine just what reduction should be made, for the amount selected would be sure to work an injustice in some cases and would not be enough for others, even if the boilers were in the same service, the experience of the firemen, the grade of the metal, and the care given the boilers being the determining factors. At any rate it is argued that such a step would be in the right direction, and, although unjust to some, would have a tendency to reduce the number of boiler explosions, which, of course, is the end sought.

Viewing the matter impartially, it would appear that the factor of safety of four to five usually adopted in construction is small enough for security at any time, and that the difference between working and bursting pressures should be as great, or even greater, in an old boiler as in a new one. One way to maintain this margin is to adopt a uniform scale of pressure reduction, graduated according to the age of the boiler. Another way, and the one which is now in force, is to leave it to the judgment of the inspector. Much might be said in favor of either.

The Results of Experience

There being desired information as to the adaptability of the steam turbine to a particular field, the simplest formula for the solution of the question would appear to be to ask a number of people who had them in use upon that service.

This is what the Committee on Power Generation of the American Street and Interurban Railway Engineering Association did. To the inquiry, "What is the difference between turbine plant and reciprocating-engine plant in fuel consumption per kilowatt-hour under like conditions of load?" one reply says that the engine uses 30.96 and the turbine 19.35 pounds; one that the turbine is twenty-five per cent. better than the engine, the load factors being 50 and 65 for the turbine and engine, respectively; another that the total cost in the turbine plant is about seventy-five per cent. of that in a Corliss compound condensing; one says the turbine is ten to twenty per cent. better and two place its advantage at fifteen per cent.

On the other hand, one gives the engine at 2.69 and the turbine at 2.84 pounds, which is over five per cent. to the good for the engine. Another says: "Turbine uses about ten per cent. more steam than the engine;" another, "About six per cent. in favor of engines;" another, "Engines a little more economical with us." Four, while they give no results, are generally favorable to the turbine; and eight can find no difference.

It would seem, then, that there are some factors lacking in the formula.

One trouble is that the question as put is very broad and the replies need analysis in the light of further information. A reciprocating-engine plant may be anything from a single-valve simple noncondensing to a multicylinder engine running upon superheated high-pressure steam and exhausting into a nearly perfect vacuum. While the types of turbine unit are not likely to have differed so widely as seriously to affect the results, their capacities, the conditions of load factor, pressure, superheat and vacuum, all of which seriously affect their performance, are likely to be widely different. By comparing a 10,000-kilowatt turbine, with high pressure, superheat, vacuum and load factor, with a 1000-kilowatt power engine-driven unit, with low pressure, superheat, vacuum and load factor, and, conversely, by comparing a large engine unit running under the most favorable conditions with an insignificant turbine unit, underloaded and without adequate pressure, vacuum and superheat, an even greater range of results than the committee has elicited could be obtained.

Notwithstanding all that is said about high vacuum, only one of the respondents claims to get over 29 inches, and he says from 28¾ to 29¼, indicating that the higher is the maximum and occasional value, and the average for the thirty-two replies would be between 27 and 28 rather than higher.

More uniformity would be expected in response to the inquiry as to whether the turbine or the engine had an advantage in point of time required for starting up, but it will be seen by inspecting the answers on page 710 that there are those who are willing to testify that turbines can be started in half the time, and others equally positive that engines have the advantage.

So that it is not so simple a thing after all to tell which will be the better for a given situation, even if you have access to the experience of him who has used both kinds.

The Wisconsin Corliss Releasing Gear

A Gear for High Speeds with Many Constructional Features Designed Primarily for Strength and Convenience of Operation and Dismantling

BY OSBORN MONNETT

Mechanism for controlling the admission and exhaust of steam in the cylinder of an engine is always of great interest to the engineer; and especially is this so of the Corliss gear, which although accomplishing much the same purpose in the different designs, is susceptible of many interesting variations of detail. Certain it is that the independent control of all events in the stroke of the engine obtained by the Corliss gear will enable it to hold its own against any other method of steam distribution as long as reciprocating engines are built.

There is an appreciable amount of wear in the ordinary Corliss valve gear after it has been in service a few years; this is the cause of an increase in steam consumption and increase in the friction of the gear, and adversely affects the regulation. This point has been the subject of careful study by many designers, who have attempted in various ways to overcome the wear and make the valve gear more permanent.

High Speed for a Corliss Gear

Another quality greatly to be desired in a Corliss releasing-valve gear is the ability to operate at higher speeds than have ordinarily been considered good practice. For many years 70 to 80 revolutions per minute was considered the limit; later 90 to 100 revolutions per minute were found to be safe speeds, but at the present time 120 revolutions per minute is a speed often used. Higher speeds are desirable because of the large saving in the first cost of installation, especially when the engine is direct-connected to a generator, and because it often makes it possible to get a Corliss engine unit of the desired capacity in a space which would otherwise necessitate the installation of a high-speed engine unit or a small turbine.

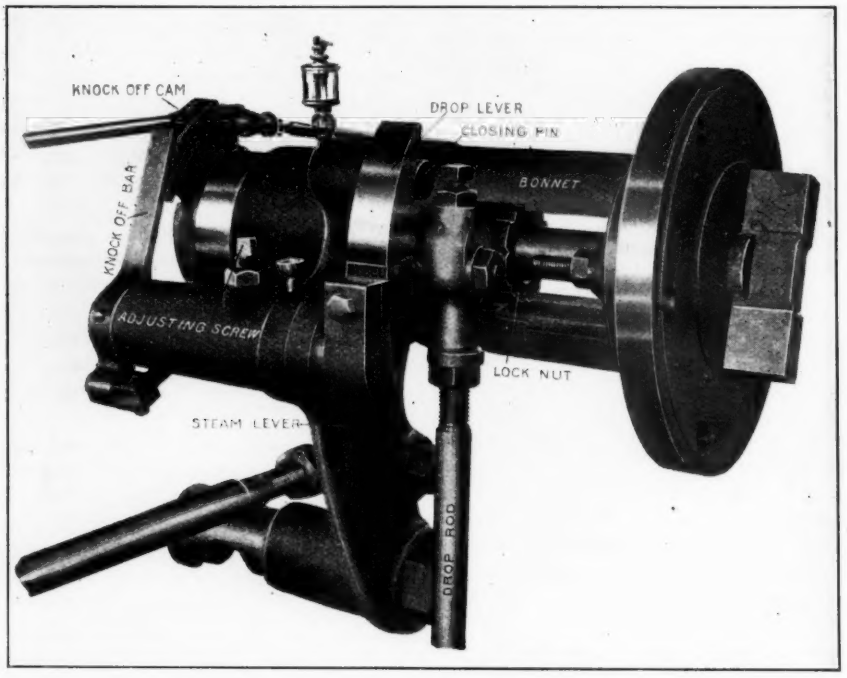


FIG. 1. INSIDE VIEW OF RELEASING GEAR

The gear here described is of exceptional interest because it has made possible speeds of 150 to 175 revolutions per minute with perfect regulation, low friction loss, and a low steam consumption over a long term of service. It was designed in 1900 and first put into service in 1901 on engines built by the Brown Corliss Engine Company. Since that time it has been applied to all the engines built by that company and its successor, the Wisconsin Engine Company, at Corliss, Wis.

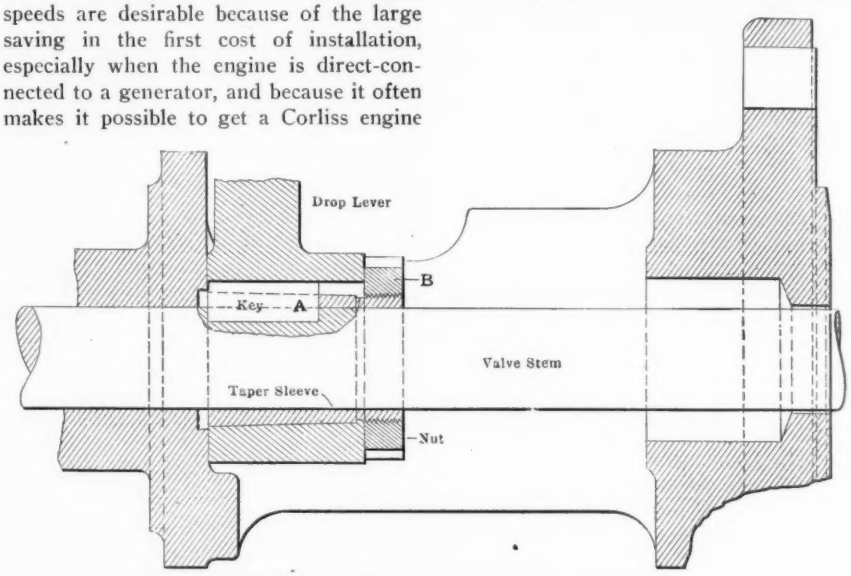


FIG. 2. METHOD OF SECURING DROP LEVER TO VALVE STEM

Heavy Parts of Gear near Cylinder

The valve gear contains many constructional features of interest. In the design of this gear it has been the endeavor to have the parts subjected to the most strain placed as near the cylinder as possible, to get the benefit of rigid support and to reduce the leverage of the gear on the bonnet. Thus, it will be noticed in Fig. 1, that the drop lever is inside the bonnet, rising and falling through the inside opening in the casting. Besides bringing the valve gear nearer to the cylinder, this construction offers the additional advantage of giving a substantial bearing to the valve stem on each side of the point where the turning movement is applied. One of the peculiarities of this valve gear is the method of attaching the drop lever to the valve stem; this is done by means of a split taper sleeve set up with a lock nut,

as shown in Fig. 2, and held to the valve stem by friction as well as the key *A*, against which the split edges of the taper sleeve snugly fit. When the nut *B* is driven up, the valve stem, key, taper sleeve and drop lever are locked together as firmly as though these pieces were formed from one solid forging.

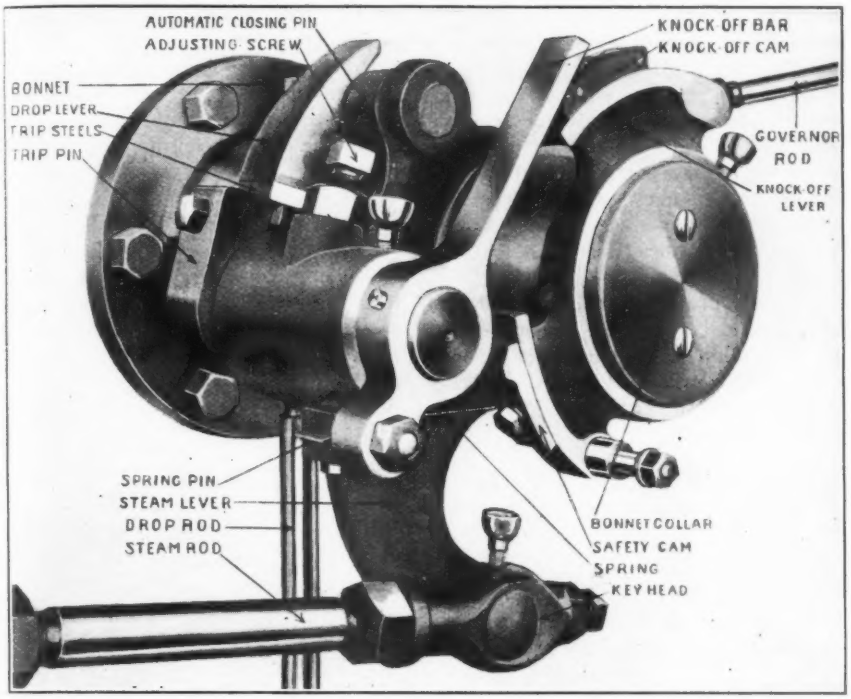


FIG. 3. OUTSIDE VIEW OF GEAR

Lap of Trip Steels Adjustable

The steam lever has a long bearing on the bonnet immediately outside of the drop lever, and carries the trip pin and trip steels by which the drop lever is engaged and the steam valve is opened. The trip steels are square and interchangeable, and, in accordance with the best practice, are made so that any one of the eight sides may be used as a wearing surface. An annoyance which is frequently met with in Corliss engine operation is the wearing away or sudden breaking off of the edges of these steels and the consequent refusal of the drop lever to pick up and open the steam valve; this is obviated in the design under consideration by an arrangement for controlling the lap of these steels while the engine is in motion. The trip pin, shown in Fig. 3, contains a V-shaped recess, one side of which is held by a flat steel spring against the adjusting screw, also shown in the figure. Adjusting this screw varies the relative positions of the two steels, so that their lap may be increased when required, making it unnecessary to shut down because of any trouble with the trip steels.

Closing Pin an Important Feature

In the foregoing illustrations the automatic closing pin undoubtedly will have received attention. This is another valuable feature of this gear, and, as apparent in Fig. 1, it is held in the casting of the steam lever. Ordinarily it performs no service, but should the dashpot for any reason fail to close the steam valve, the closing pin forces down the drop lever and closes the valve mechanically, thereby making it impossible for the engine to take steam on both ends of the stroke at the same time.

At the outer end of the bonnet, where they are accessible for inspection, are carried the lighter parts of the gear, such as the knockoff bar, cam and lever, thus carrying out the idea of bringing the heavy work of the gear near the point of support and the lighter work farther removed; this minimizes the strain on the bonnet casting and preserves the alinement necessary for close-fitting parts, minimum friction loss and close regulation by the governor. It will be noticed in the end and side elevation of the gear, Fig. 4, that the knockoff lever through which the governor controls the cutoff is placed at the outer end of the bonnet where it is practically free from disturbance by the other working parts. There is but one light rod connecting the governor lever with the knockoff lever on the bonnet at the crank end of the cylinder, and a light rod connecting the crank-end knockoff lever with that on the head-end bonnet; this not only dispenses with the long rod and its lever between the governor and the head-end bonnet, but greatly reduces the weight and consequently the inertia of the parts which must be moved by the governor to control the cutoff. The governor and gear consequently work in harmony to secure close regulation.

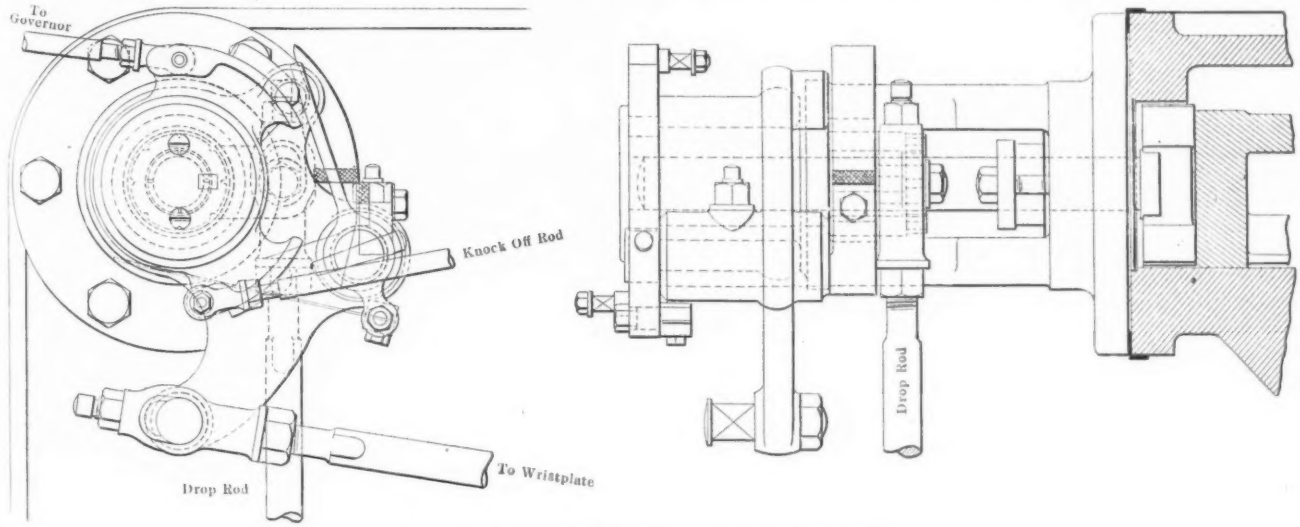


FIG. 4. FRONT AND SIDE ELEVATIONS OF VALVE GEAR

No Wristplate for the Steam Valves

In the standard high-speed design no wristplate is used on the steam valves, the motion being transmitted through straight

rods direct from the eccentric. This considerably reduces the weight of the steam-valve driving gear, and by the use of double-ported valves, both steam and exhaust, the movement and momentum of the moving parts are decreased, making everything favorable to the high speeds previously mentioned. Ample wearing surfaces and lubrication facilities are provided to insure continuous operation at these speeds and the gear is set so that the governor controls the cutoff from naught to seven-eighths of the stroke—a long-range valve gear.

When the engine is standing idle, the governor collar rests on two lugs which prevent it from assuming its lowest, or safety, position; this enables the engine to take steam and start off in the same manner as a slide-valve engine, the engineer simply opening the throttle and paying no attention to the governor or the valve gear.

THE SAFETY OR "CONVENIENCE" DEVICE

The safety device consists of a rider wheel on the governor belt, which by a system of levers controls the position of the above-mentioned lugs. As long as the governor belt is intact, the lugs remain upright and support the governor collar in the position for seven-eighths cutoff, the cutoff being decreased as the engine speed rises. In the event of the belt breaking, the dropping of the rider pulley removes these supports for the governor collar, which then, of course, assumes its lowest position, bringing the safety cams into play under the knockoff bars and making it impossible for the engine to take steam. Thus it is seen that the safety device is entirely automatic in action, there being no levers or pins to manipulate by hand in order to render it operative; consequently there is no chance for disaster caused by the forgetfulness of the engineer. The name "safety device" as applied to this and similar contrivances is really a misnomer; the engine would be just as safe without it and the lugs which support the governor in its lowest position when the governor belt is intact. Rather, these are "convenience devices," as they relieve the operator of the necessity of raising the governor to the running position, from the safety position into which it would fall without them, when the engine is shut down.

A feature of this valve gear, which will be appreciated by operating engineers, is the ease with which all parts of the mechanism may be dismantled, it being only necessary to remove the bonnet collar, held on by the two screws shown in Fig. 3, to take off all parts of the valve gear in their regular order, until nothing is left but the bonnet and drop lever.

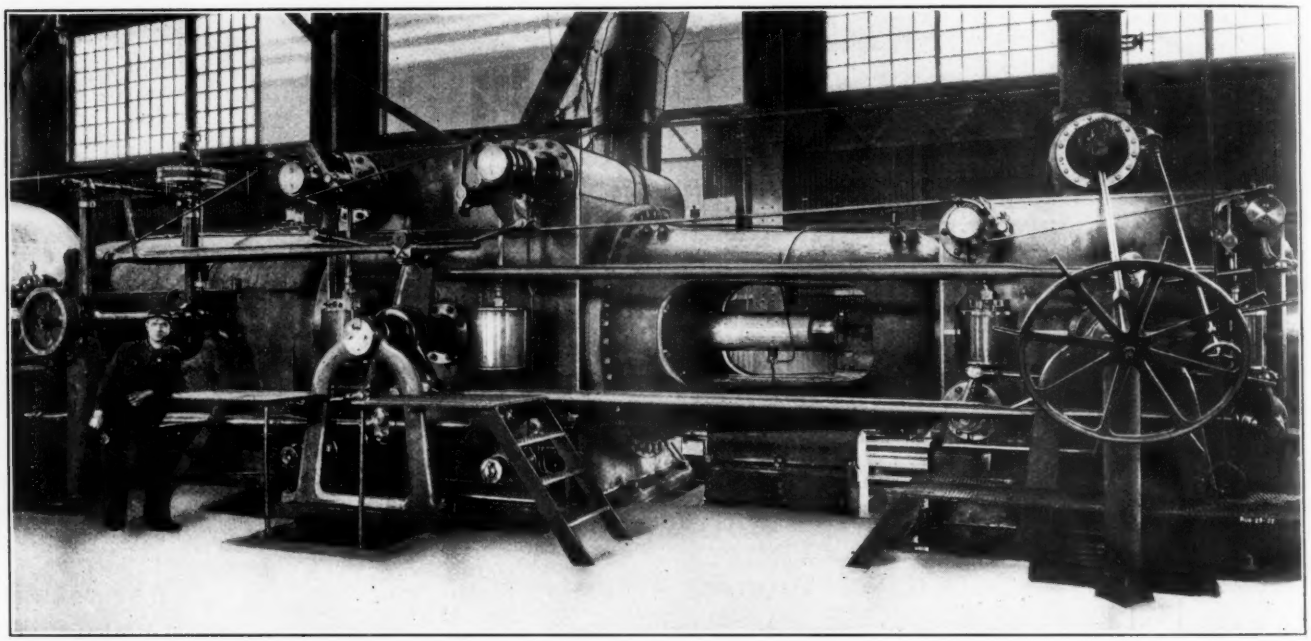


FIG. 5. VALVE-GEAR SIDE OF WISCONSIN CORLISS ENGINE

Temperature of Coal Piles

For determining the temperature of a coal pile a special coal auger has been designed and is used by the coal department of the Arthur D. Little Laboratory, Boston. It is similar in form to that used in the mines, but is provided with a means of inserting a small maximum thermometer near the point. Extensions 4 feet in length (for convenience in carrying) may be attached to the auger so that the thermometer can be inserted into any depth in a pile. The point of the auger can be driven 20 feet in from three to five minutes.

A New Wile Gas Producer

The Gas Machinery Company, of Cleveland, Ohio, has taken up the manufacture of the Wile suction gas producer for power purposes, which has been considerably improved in several important details. Figs. 1 and 2 herewith show partly sectional elevations of the complete outfit, the views being at right angles to each other.

The generator is simple in construction and differs from the ordinary plain cylindrical type only in being equipped with a fuel reservoir smaller in diameter than the main body and set into the top of the latter, as clearly indicated in Fig. 1. The charging hopper empties into this reservoir.

The vaporizer consists of a cylindrical shell containing two coils of pipe, one nesting within the other, as indicated in Fig. 1. The water is fed into these two pipe helices, and vaporized therein by the heat from the gases in the surrounding drum, through which they pass to the scrubber. The lower ends of the pipe coils open into tees in the air-intake pipe of the generator. The inlet ends of the pipe coils are water-sealed, the water being delivered from the regulator into two funnels, the spouts of which extend down into the intake pipes below the openings in the sides of the latter, through which the water overflows into the upper ends of the pipe coils.

The water regulator is ingeniously simple and sensitive. A sectional elevation of it is shown in Fig. 3. The constant-level chamber *A* is supplied through a water seal and communicates at the bottom with the suction chamber *B*, which

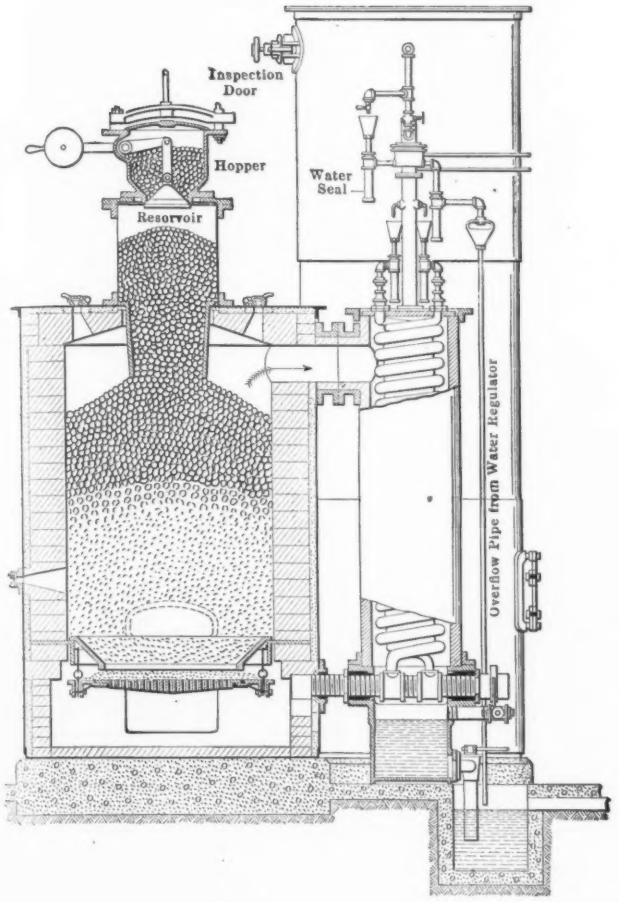


FIG. 1

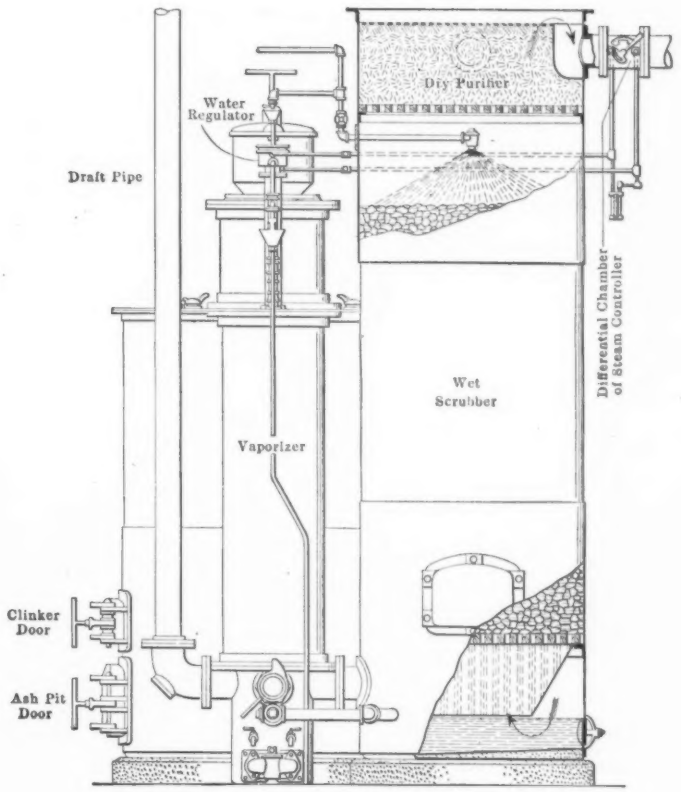


FIG. 2

GENERAL ARRANGEMENT OF WILE PRODUCER

is tightly closed at the top. The suction chamber is connected by a small pressure pipe with one end of a "differential" chamber and the constant-level chamber is connected by another pipe with the other end of the differential chamber. The latter contains an adjustable baffle in the form of a flat butterfly or damper-type valve, and is inserted in the supply pipe between the engine and the producer plant. The engine suction produces a partial vacuum in the differential chamber, of course, and the pressure on one side of the baffle is higher than that on the other side. This difference of pressure is communicated to the chambers *A* and *B* in the regulator and causes the water in the latter to rise high enough to overflow through the holes in the central hood into the chamber *C*, whence it passes to the funnels which deliver into the water seals at the inlets of the vaporizer coils. Fig. 3 shows all these connections and indicates how the baffle in the differential chamber is adjusted to produce greater or lesser differences of pressure on opposite sides of it. The greater the difference of pressure, the higher will the water rise in the chamber *B* and, consequently, the more steam will be delivered to the fuel bed of the generator.

Another new feature of the producer is the water valve between the generator and the scrubber by means of which the gas from the generator may be turned into the waste or draft pipe until it attains the proper quality, and then into the scrubber. This is illustrated in Fig. 4, and consists of a pot bolted to the lower end of the vaporizer and containing three incomplete partitions. The two upper partitions divide the main portion of the pot into three compartments; the central one opens into the shell of the vaporizer, whence the gases from the generator flow into the center of the pot; one side compartment connects with the draft pipe and the other with the scrubber.

The third partition extends from the bottom of the pot up, between the other two, to a small inlet through which the

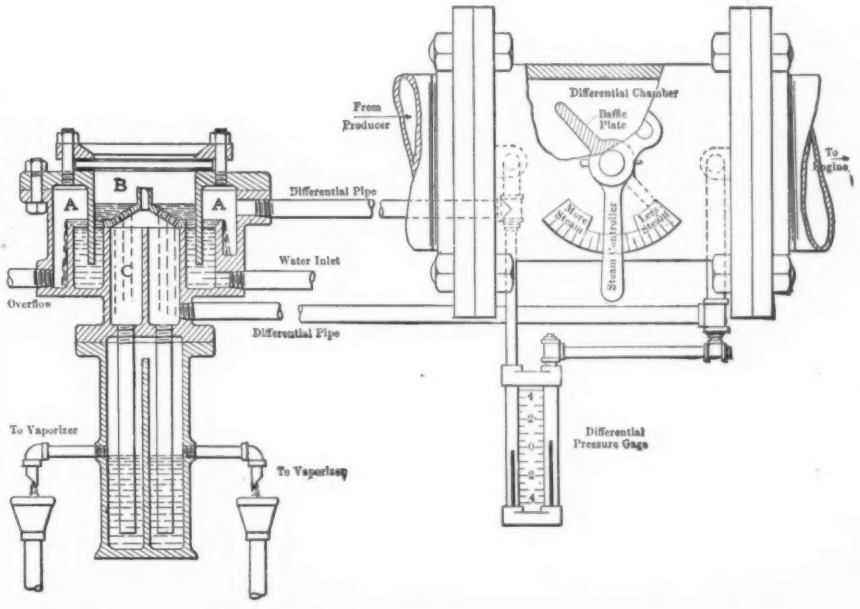


FIG. 3. WATER REGULATOR AND STEAM CONTROLLER FOR WILE PRODUCER

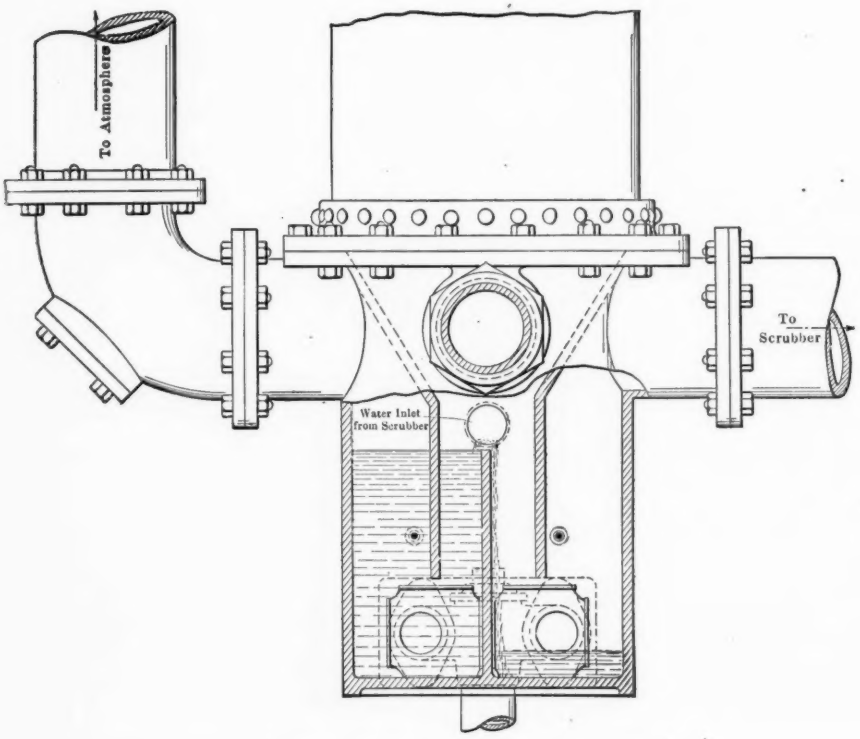


FIG. 4. THREE-WAY WATER VALVE, WILE PRODUCER

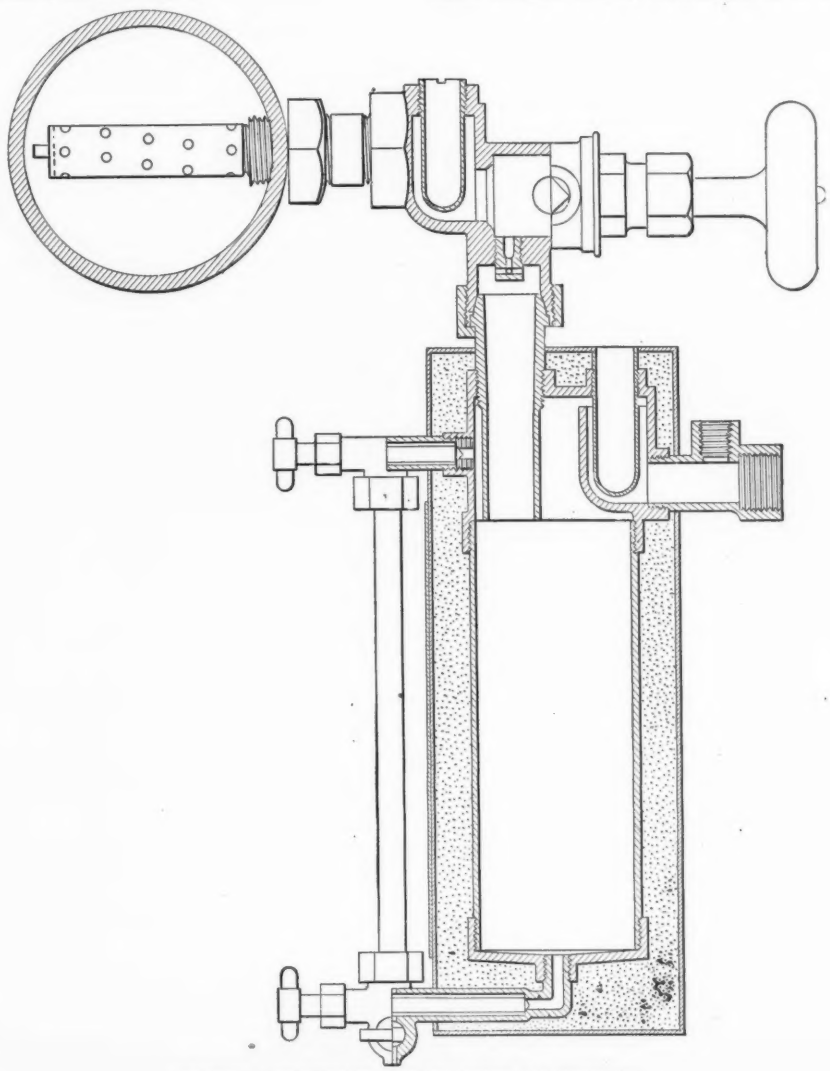
waste water from the scrubber enters the pot. Near the bottom of the pot is a U-connection which straddles the central partition and in the center of which is a cock that opens either leg of the U to a waste pipe. The scrubber water keeps a seal on one side or the other of the central partition, according to which way the waste cock is turned; if the right-hand compartment (as the drawing is made) is open to the waste pipe, the water runs out of that side as fast as it runs in, but it is held in the other side up to the top of the central partition, sealing the draft-pipe outlet. Turning the waste cock the other way empties the water out of the draft-pipe compartment and forces it to fill up the compartment opening to the scrubber. The advantage of this arrangement is that no valve seats are exposed to the hot, dirty gases, and, consequently, there is no liability to gas leakage, due to deposits on valve seats, or the warping of valves by heat.

The grate of the generator is flexibly hung, as shown in Fig. 1, and a shallow hopper is provided immediately above the grate to support the edges of the fuel bed and prevent "chimneying" up the sides of the generator. The dry purifier is located in the upper end of the scrubber shell, the wet and dry compartments being separated merely by a wooden grid which supports the excelsior or whatever material is used in the dry filter. This construction obviously eliminates the usual pipe connection between the wet and dry cleaners and decreases the floor space considerably.

Ellison Throttling Evaporating Calorimeter

In the Ellison throttling evaporating calorimeter the steam is throttled direct into the steam and water chamber, forming a combined throttling, separating and evaporating calorimeter in one chamber, having both a down- and an up-flow steam path; the superheated steam evaporating any intermittent excess of moisture separated from the throttled steam, and lowering the temperature at the outlet or calorimeter thermometer in exact proportion to the amount of evaporation of such separation without any other calculation than that of a throttling calorimeter.

The steam travel is about 15½ inches, 9 down and 6½ up, which is claimed to be the longest travel for a given-sized chamber of any calorimeter known. Any moisture not evaporated by the throttling process or separated on the down-flow is separated on the up-flow, the moisture falling back by reason of the steam rising from the moisture at very low velocity. Near the top of the chamber the steam turns at right angles, flowing down to the



ELLISON THROTTLING EVAPORATING CALORIMETER

outlet about the well of the calorimeter thermometer, where the final temperature, or temperature of the throttled and superheated steam is taken. If there is any excess not evaporated, the gage glass is turned on, which indicates on a scale the amount of water in one-hundredths of a pound, which is added to the percentage of moisture indicated by the thermometer, the water being drawn off at the stop cock. The gage glass shuts off at the inside of the jacket, and has no radiation when not in use.

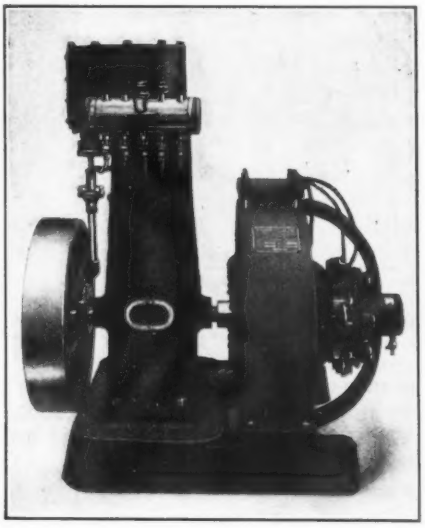
The calorimeter thermometer and steam chamber are protected from radiation in the most effective manner by a ½-inch filling of loose lampblack, jacketed with brass tubing, nickel-plated.

The throttling plug is provided with an atomizer. Steam flowing from the throttling orifice at high velocity strikes a flat surface in the lower end of the plug, breaking up any globules of water contained in the steam and dividing the steam into four fine streams, meeting below the plug and effecting a perfect mixture in the inlet tube. The plug is made of 35 per cent. nickel steel, interchangeable and noncorrosive, with the orifice reamed to an exact size of 3/32-inch diameter, and is tempered. Plugs of any other diameter of orifice are also made. The plug being in the body of the valve, the steam joint of the union is subject only to the calorimeter pressure, or practically that of the atmosphere. For superheated steam the calorimeter may be disconnected at the union, the throttling plug serving as a circulator for the live-steam thermometer.

The outlet nozzle is also reamed to exact size, so that the pressure in the calorimeter for a given size of throttling orifice and steam-pipe pressure may be known without the use of a manometer by reference to a table furnished with the instrument. A mercury gage for testing the pressure when desired is furnished, and is attached in top of the outlet nozzle. To prevent the possibility of any aspirating effect, the aperture is made in the form of a narrow slot in the wall of the nozzle.

The thermometer wells have thin walls and are made from 35 per cent. nickel-bar steel, noncorrosive, and are not affected by mercury when used in preference to oil. The thermometers can be tested for accuracy by connecting a corrected test gage with the threaded opening in the side of the valve, or any steam gage used in a test can conveniently be compared with the test gage by connecting it with a similar opening provided on the opposite side of the valve. The openings being back of the valve seat, connection of the steam gages can be made under full pressure in the steam pipe by simply closing the valve. The well is exposed to and in the direct path of the entering steam, and is located at the most efficient point. A thermometer, having less radiation than a test gage, is more efficient for determining the heat of the entering steam.

The valve is of special design, of 300 pounds working pressure, and, like the steam-pipe nipple, has no pockets for holding moisture. By this valve construction, the calorimeter is said not to be affected by heat of conduction. Steam condensed in the valve by heat of conduction is drained into the calorimeter and re-evaporated, balancing the effect without changing the temperature of the steam in the calorimeter. The valve and nipple are protected from radiation by a felt tape.



ENGBERG 2½-KILOWATT DIRECT-CURRENT GENERATING UNIT

The steam-pipe nipple is also made of 35 per cent. nickel-bar steel, making a durable thread and said not to be affected by superheated steam. Six sampling-pipe tips for 3-, 4-, 5-, 6-, 7- and 8-inch steam pipe are furnished, the end pieces of which are brazed in. Tips for pipes of other diameters can be obtained if wanted.

The calorimeter has no soldered joints and can be exposed to highest temperature steam. It is manufactured by Lewis M. Ellison, 6238 Princeton avenue, Chicago, Ill.

A Compact Small Generating Set

The accompanying engravings illustrate a 2½-kilowatt direct-current-generating outfit built by Engberg's Electrical and Mechanical Works, St. Joseph, Mich. The engine is of the single-valve high-speed type, with a balanced piston valve and a shaft governor; it is completely inclosed, the sides of the frame being closed by removable panels. The piston is a single-piece hollow casting and is pressed on the piston rod and safeguarded by a nut. The crosshead is equipped with phosphor-bronze shoes and the guides are bored at the same setting with the cylinder. The crosshead pin is of hardened steel, ground to size. The connecting rod is provided with a bronze bushing at the small end and an extra-wide babbitted box at the big end. The engine is lubricated from a multiple sight-feed oiler. The crank shaft and the dynamo armature are rigidly connected by a bolted coupling just inside the extreme end of the armature overhang and attached directly to the armature-core drum.

The dynamo is a six-pole compound-wound machine with form-wound coils throughout. The armature is of the modern slotted-core type, with a wave-connected drum winding, requiring only two groups of commutator brushes. The commutator is built upon an individual sleeve which is bolted to the armature drum and leaves the armature shaft free for removal, if necessary, without disturbing the commutator connections.

Two bearings are provided on the engine frame and one outboard bearing in

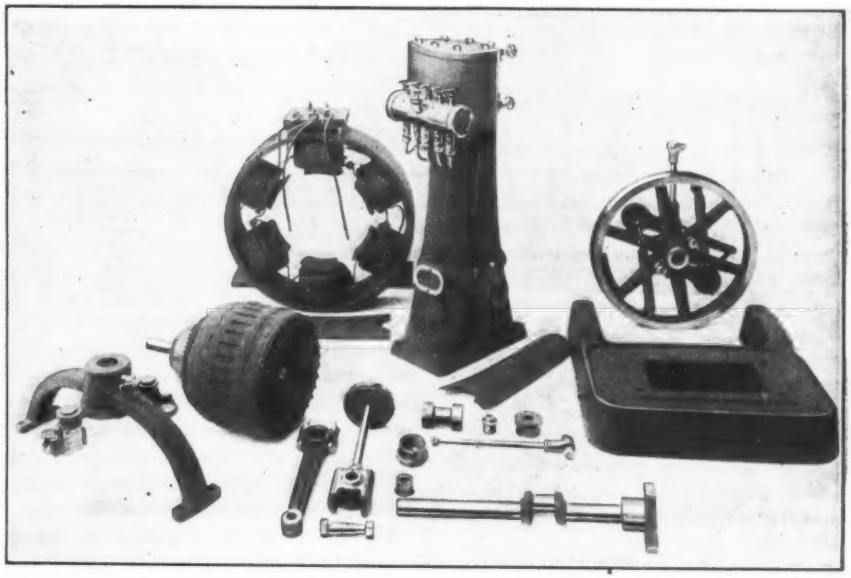


FIG. 2. ENGBERG 2½-KILOWATT D. C. GENERATING UNIT DISMANTLED

a bracket which is bolted to the dynamo frame. The two bearings on the engine are oiled from the lubricator; the outboard bearing is equipped with a reservoir and oil ring of the usual type used on electrical machinery. Fig. 2 shows the unit dismantled, and gives an excellent idea of the general construction. The complete unit occupies a floor space 20x30 inches, including the overhang of the flywheel and the outboard bearing.

Pearce Feed Water Purifier

The Pearce feed-water purifier illustrated herewith consists, as shown in Fig. 1, of a purifier box divided into sections by a series of compartments through which the feed water passes. Each partition is provided with two valves (see Fig. 2) which permit the water to flow from one compartment into the next in the direction of the arrows, and escaping through the outlet at the other end, as shown. The feed water enters at the bottom of the purifier box and passes through the upper valves the entire length of the box, while the valves in the bottom of each partition permit the water to circulate in an opposite direction. This is for the purpose of allowing the impurities in the water to settle to the bottom of the different compartments, as the cleaner water rises to the upper portion of the compartment, passing into the next, while the muddy and dirtier portion remains in the compartment apparently undisturbed, it is said.

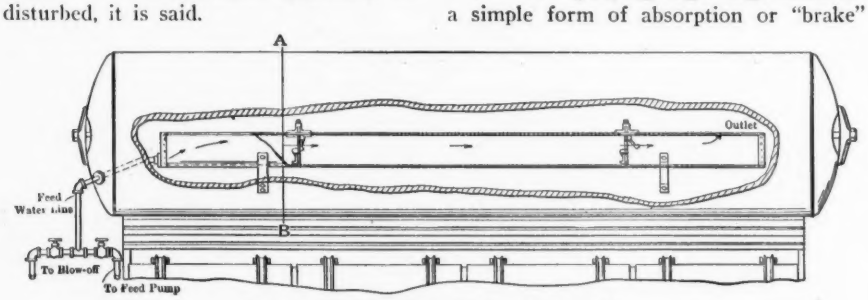


FIG. 1. PURIFIER BOX IN STEAM DRUM

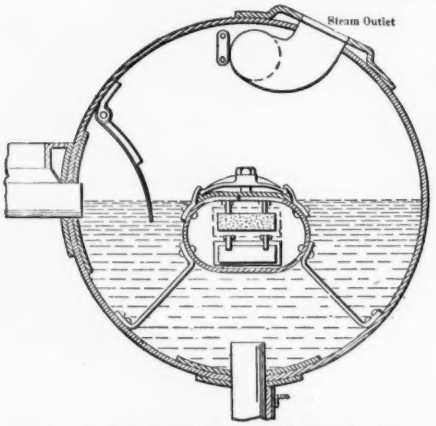


FIG. 2. END VIEW OF STEAM DRUM AND PURIFIER BOX

This device can be used with any type of boiler, and in the case illustrated, is suspended in the drum of the boiler, as shown in Fig. 2.

Provision is made for blowing out the mud of each compartment, when the boiler is blown out, through the feed-water line and blowoff pipe. It is said that this apparatus gives excellent satisfaction in the plants where it has been installed. It is being placed upon the market by Charles G. Wilfong, 1001 Chestnut street, Philadelphia, Penn.

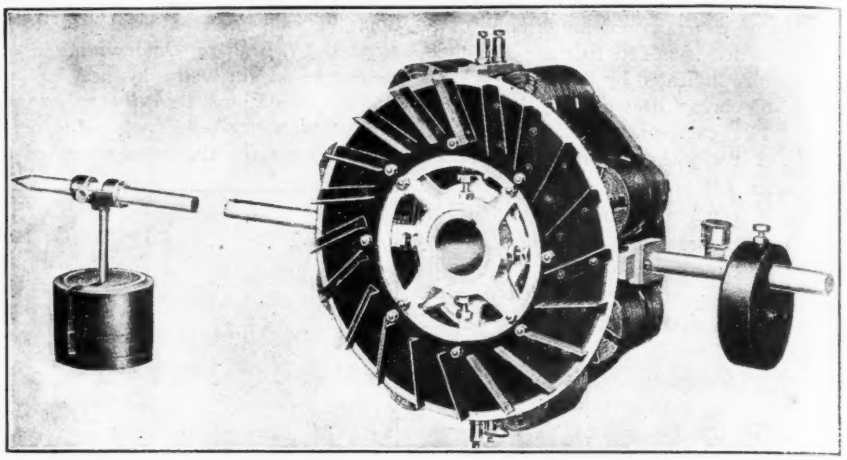


FIG. 1. EDDY CURRENT BRAKE WITH DISKS REMOVED

Eddy Current Absorption Dynamometer

The accompanying engravings illustrate a simple form of absorption or "brake" dynamometer in which the load for the tested motor or engine is produced by electrical eddy currents generated in revolving disks by powerful electromagnets. There are eight magnets of the straight-bar type, mounted in a circle on a framework with their axes parallel to the axis of the shaft of the apparatus. The shaft turns in bearings attached to the framework just mentioned, and carries two copper disks which revolve close to the ends of the magnets, one disk on each side of the structure The shaft carrying these brake disks is coupled to the motor or engine to be tested and the frame carrying the magnets "floats" on the shaft. To this frame is attached a rod which projects a considerable distance on one side and a short distance on the other, as shown in Fig. 1. On the short end is a counterweight to balance the excess length of rod on the other side, and on the long end is hung a sliding weight by which the load is measured.

The amount of load imposed is adjusted by regulating the excitation of the electromagnets. With no current in their windings, the only retardation offered by the dynamometer is the frictional resistance of its bearings. As soon as any current is passed through the windings, eddy currents are induced in the copper disks, and these oppose the rotation. The exciting current is adjusted by means of a special rheostat connected in series with the circuit, and the load is measured by the weight, exactly as in the case of a Prony brake.

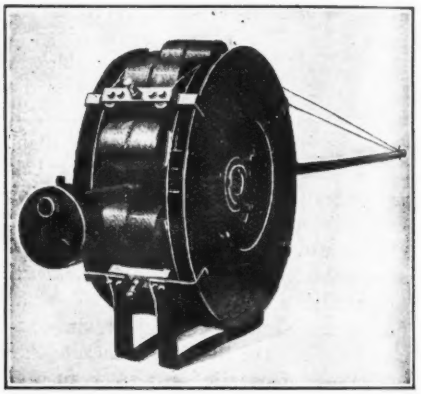


FIG. 2. COMPLETE BRAKE

Fig. 2 shows a quartering view of the apparatus complete; in Fig. 1 it is illustrated with the copper disks taken off to show the cooling vanes on the magnet frame. The machine is built by Morris & Lister, Coventry, England, in capacities ranging from 3 to 35 horsepower and suitable for speeds as high as 1500 revolutions per minute in the smallest size and 750 in the largest. The current for the magnets may be taken from any standard direct-current constant-potential circuit.

In the ordinary power plant, fuel burned represents only about half the cost of producing power.

Inquiries

Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.

Steam in a Gas Producer

Why is steam or water introduced into gas producers for power purposes?

S. J. K.

To keep the temperature of the fuel bed down to a practical point and to enrich the gas; the hydrogen in the steam increases the heat value of the gas very much.

Starting a Corliss Engine

A Corliss engine that cuts off at ¼ stroke is stopped with the piston at the middle point of its travel and, consequently, with both steam valves closed. How would you start it?

J. B.

Work the valves with the hand bar in the wristplate.

Gas and Gasolene Engines

Can a gasolene engine be operated on illuminating gas without any change in the engine?

W. J. L.

Generally, no. The arrangements for introducing gas are different from those for gasolene, and the gas engine should have considerably higher compression.

Direct-current Transmission

Why is not direct current used for transmission purposes as well as alternating?

T. M. O'C.

Because the high potentials necessary for economy in line construction cannot be "commutated." They would jump across the insulation of any commutator that could be commercially constructed.

Pump Suction Limit

Why will a pump not lift water a distance nearly equal to the head balancing atmospheric pressure—say 32 or 33 feet?

K. M. D.

Because the pump is not sufficiently tight to maintain so high a vacuum, and also because of the vapor tension of the water. Even with an absolutely perfect pump, water could not be lifted 32 or 33 feet because it would evaporate under the high vacuum required.

Specific Gravity of Gasolene

What is meant by saying that gasolene has a specific gravity of 69, or 71, or some other figure?

W. J. L.

That any volume of gasolene weighs 0.69 or 0.71 of the weight of the same volume of water at the same temperature. If the specific gravity is expressed in degrees, however, the meaning is different. Gasolene of 0.70 specific gravity will show about 75 degrees on a Baumé hydrometer, and 0.74 specific gravity = 60 hydrometer degrees.

Bubbling of a Storage Battery

What causes the bubbling at the surface of the liquid in a storage battery being charged?

T. N. D., Jr.

The liberation of gases by chemical reaction due to the passage of current through the cell. When bubbling becomes very active it indicates that all or nearly all of the gases liberated are escaping because the chemical changes due to "charging" are practically completed and there is no more work for the gases to do within the cell; therefore, it is time to stop charging.

Isothermal Expansion of Steam

Is the temperature of steam in an engine cylinder just before the exhaust port opens the same as when cutoff occurs? If not, why is the expansion curve of an indicator diagram called the curve of isothermal expansion?

W. F. L.

No; the temperature falls with the pressure. The hyperbolic curve is the isothermal expansion curve of perfect gases (which form the basic hypothesis of thermodynamics); hence its name. Steam is not a perfect gas, even when superheated; its isothermal expansion "curve" when saturated is a straight line.

Compound and Differential Motors

What is the difference between a compound-wound and a differentially wound motor, in construction and operation?

E. K. W.

The series-field winding of a compound-wound motor is connected so that it assists the shunt-field winding; consequently, the field strength increases with the load and the speed varies oppositely to the load, but not equally. The series winding of the differential motor opposes the shunt-field winding; consequently the field strength is decreased by an increase of load. The proportions are such that the inverse variation of field strength keeps the speed absolutely constant at all loads. The motor will not start with a heavy load unless the series-field winding is short-circuited, whereas the compound-wound motor will start with abnormal loads.

Live or Exhaust Steam for Heating Kiln?

With a 50-horsepower boiler supplying live-steam heat to a dry kiln at 120 pounds pressure, find the equivalent exhaust steam to give the same heat. The steam as generated runs to a coil heater with 3600 feet of 1-inch pipe, the heat being forced to the kiln by a large fan. The condensation is taken from the heater and returned to the boiler by a small boiler-feed pump. Now, it is proposed to make the following change: We have an 18x36-inch Corliss engine running noncondensing, with the exhaust going into the atmosphere, the engine doing 250 horsepower. We intend to put on a back-pressure valve, set at 4 pounds, and heat this kiln with the exhaust from this engine. Would such change be practicable?

E. A. S.

We understand that the steam stands in the coils at 120 pounds pressure and that the condensation is drawn out at this pressure and passed around to the boiler. Neglecting radiation from the returning water, all that the boiler has to do is to evaporate the water "from and at" 350 degrees, the boiling point at 120 pounds. Fifty boiler horsepower equals

$$50 \times 33{,}305 = 1{,}665{,}250$$

thermal units per hour. The 50-horsepower boiler, if worked to its capacity, passes this number of heat units into the kiln per hour at 350 degrees temperature. Your Corliss engine would use some 30 pounds of steam per hour per horsepower, and would therefore use

$$250 \times 30 = 7500$$

pounds of steam per hour. Suppose 10 per cent. of this is reduced to water by the conversion of heat into work and radiation; you would have available

$$7500 \times 0.90 = 6750$$

pounds of steam at 4 pounds back pressure. Each pound of steam condensing at this pressure gives up 956.3 heat units. There would, therefore, be available for the kiln

$$6750 \times 956.3 = 6{,}455{,}025$$

heat units per hour, as against 1,665,250 from the high-pressure boiler; but this would be at a temperature of 225, instead of 350, degrees. If this temperature is sufficiently high you will have plenty of heat, but may need more heating surface to transfer it with sufficient rapidity at the lower temperature, and the piping system must be so designed that the water with which the exhaust steam is laden may not obstruct the circulation.

A separator and, if convenient, a reheater are advisable on the exhaust. If the exhaust steam could be passed through a superheating coil in one of the boiler furnaces without too much complication the difficulties of its use would be materially decreased. Your engine would develop at 600 feet of piston speed 4.626 horsepower per pound of mean effective pressure. Your back pressure of 4 pounds would be equivalent to

$$4 \times 4.626 = 18.5$$

horsepower, which would call for about

$$18.5 \times 30 = 555$$

pounds of steam per hour more from the boiler supplying the engine, or 18.5 instead of the present 50 horsepower.

Boiler and Flywheel Explosions and Elevator Accidents

According to the Fidelity and Casualty Company's list, there were reported 15 boiler explosions in this country between August 18 and September 17, inclusive, and two cylinder-head accidents. These include four locomotive disasters. Five bursted flywheels were reported between August 28 and September 11, inclusive, and from August 8 to September 22 there were 35 elevator accidents, mostly of persons falling down the elevator shaft, although there were three cases of broken cable. Altogether these explosions and accidents caused the death of 25 persons, and injury of more than 50, to say nothing of the property loss.

November Meeting of the A. S. M. E.

The November meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies' building, 29 West 39th street, New York, on Tuesday evening, November 10. Franklin Phillips, president of the Hewes & Phillips Iron Works, Newark, N. J., will make an address on "The High Powered Rifle and its Ammunition; Instruments of Precision," illustrated by lantern slides. Mr. Phillips is an expert marksman, and in 1903 won the position as first alternate on the international rifle team to England. He was for many years chairman of the committee on rifle and pistol practice in the National Guard of New Jersey and is now ordnance officer of the second infantry of that State.

Association of Engineers-in-Charge

The program for the 1908-09 session of the Association of Engineers-in-Charge, London, England, includes the following:

October 14, paper by James Swinburne, on "Smoke."

December 9, paper by W. H. Booth, on "Coal, its Composition and Combustion."

January 13, paper by John B. C. Kershaw, on "Water and its Impurities."

February 10, paper by H. B. Poynder, on "Polyphase Motors for Machinery Driving."

March 10, paper by W. A. Tookey, on "Indicator Diagrams."

March 27, annual dinner.

Obituary

Chester G. Bliss, one of the best-known operating engineers in the vicinity of New York City, died October 13 at his home at Nyack, N. Y., after a short illness. He was about 60 years of age. Mr. Bliss was formerly chief engineer of the Sixty-fifth street power house of the Third Avenue Railroad Company, when it employed the cable system, and afterward became chief operating engineer for the Metropolitan Railway Company. For some time previous to his decease he was chief engineer of the Ninety-sixth street station of the Metropolitan Railway Company. Deceased was one of the early members of Phoenix Association No. 24, N. A. S. E., and was also a Mason. The funeral, which was Masonic, took place Friday, October 16. Mr. Bliss is survived by a widow, two sons and one daughter.

Personal

R. M. Neilson, lately chief of the technical department at the Hartlepool works (England) of Richardsons, Westgarth & Co., Limited, has opened an office at 45 Hope street, Glasgow, as consulting engineer and patent expert.

Business Items

A very pretty calendar is being sent out each month by the Stephenson Manufacturing Company, 68 State street, Albany, N. Y. Our readers may obtain the series by sending their names and addresses and mentioning this paper.

The Buckeye Engine Company, Salem, O., builders of steam and gas engines, has greatly increased the capacity of its plant by the addition of several new buildings. Recent orders have compelled them to run the enlarged plant day and night since October first.

One of the most attractive pictures of stationary steam engines that has ever come to hand is a three-color representation of a Murray-Corliss engine, recently received from the Murray Iron Works Company, Burlington, Iowa. The picture is mounted on heavy bristol board, with a wide mat, the overall dimensions being 9x13 inches It is ready to be framed, and the company will gladly send one to any engineer who wants it for his engine-room wall.

Having discontinued the manufacture of cars for many years past, and realizing the importance of a more descriptive firm name, the Cleveland Crane and Car Company, of Wickliffe, Ohio, will hereafter be known and operate as the Cleveland Crane and Engineerng Company. Under such title the production will be confined to the exclusive manufacture of cranes of every description, including traveling, gantry, mono-rail and grab-bucket handling equipment of various types.

The Buckeye Boiler Skimmer Company, South End, Toledo, Ohio, has received a letter from the Michigan Condensed Milk Company, which states: "We are so well pleased with the floating skimmers which you installed in our Babcock & Wilcox boilers at our Mt. Pleasant, Mich., factory, that we take pleasure in saying that after three months of hard work, we opened one of the boilers to see how it looked and found no mud and practically no scale. Everything is just as you stated, and the cost of using them is so small it would be impossible for us to figure it, which means practically nothing."

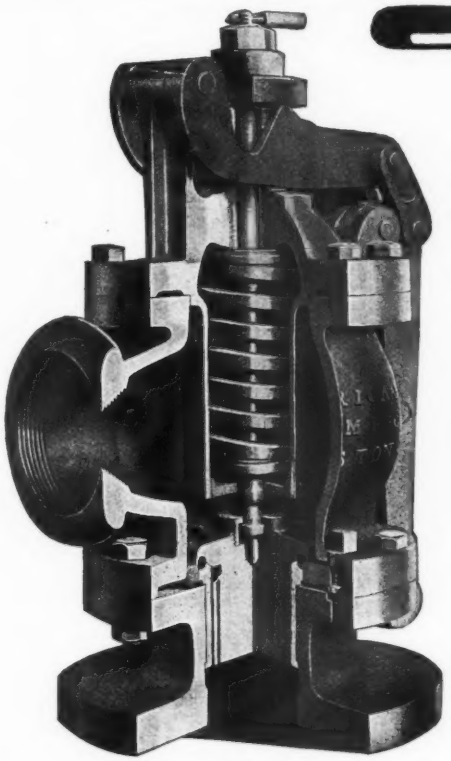
The Continental Natural Gas Alcohol Company, of Wheeling, W. Va., informs us of the contemplated erection of a plant at Wheeling to manufacture denatured alcohol, for light, heat and power purposes, from natural gas. It is stated that 5000 feet of natural gas will produce about 50 gallons of alcohol, 5 gallons of alcohol being equivalent, in heating units, to about one cord of hardwood, or 1 3 tons of lump coal. The company is prepared to negotiate with commercial associations or individuals for the establishment of similar plants wherever they can be located near the natural-gas belt.

The G. M. McKelvy Company of Youngstown, Ohio, has placed an order with the Nernst Lamp Company for the new Westinghouse-Nernst lamps for the entire lighting of its new four-story store building, to be occupied this month. The installation will consist of thirty-six 3-glower lamps for the first floor, sixty-nine 2-glower lamps for the second and third floors and seventy-five 132-watt lamps for the basement and fourth floor. This is the largest department store in Youngstown. The building now occupied by the McKelvy Company has been lighted by the old-style Nernst lamps for several years.

The Nelson Valve Company, Philadelphia, reports that it is behind in its orders and that the demand for Nelson valves has compelled another enlargement of the plant. About a year ago the Nelson Valve Company increased its capacity nearly 100 per cent. and has been compelled to increase again, having secured two and one-half acres additional, on which a modern new shop 200 feet long has been erected, equipped with new and modern tools. The management is contemplating the erection also of a 100-foot addition to the brass foundry, which will be equipped with oil furnaces and power molding machines of the latest type.

The Standard Gauge Manufacturing Company, which has been actively engaged in the manufacture of indicating and recording gages at Syracuse, N. Y., will remove its plant and main office to its new factory at Foxboro, Mass., on or about November 1. Through this change the manufacturing capacity will be greatly increased, since the two main buildings alone have available floor space of 100,000 feet, besides separate foundry buildings, blacksmith shop, carpenter shop and power plant. The growth of the Standard Gauge Manufacturing Company has been steady since its modest inception in 1899, so that this epoch in its development will not surprise its many patrons, who look upon its products as standards of quality and finish.

Much interest is felt in the outcome of the efforts which are under way for the adjustment of the affairs of the Westinghouse Electric and Manufacturing Company. Several prominent officials of that company, in discussing the matter, express their views about as follows: The plan of reorganization which has been proposed is not only fair to all the creditors but at the same time it gives some consideration to the interests of the stockholders. What it really amounts to is an extension in the time of payments of the various debts. The merchandise creditors have come up splendidly, and almost the entire number have accepted the plan. The bankers have been somewhat slower than the merchandise creditors and it is on them, more than on any other class of those involved, that the ultimate success of the plans depends. It they show a moderate amount of liberality, and, above all, if, as Americans, they have any pride in the great company which is really a national institution, they will not delay in doing their part toward the rehabilitation of the company. It is the belief of the most competent financial men among the banking interests which have already participated in the plan that they are conserving their own best interests in the most thorough manner. The stockholders are doing their part also, although, as shown by the recent letter of George Westinghouse, a number of them have still to contribute their part. In short, it is a case of the old saying, "A long pull, a strong pull and a pull all together," and the company will be on its feet, and with the return of general business prosperity will be the same prosperous concern that it has always been.



Carefully Tested
Fully Guaranteed
Many Special Features

For Many Years the Foremost Engineers Have Considered the AMERICAN Special Pop Safety Valve the Best in the World

HERE are a few of the special features that have placed the American Special Pop Safety Valve in a pre-eminent position as the surest, safest Pop Valve in the market—

¶ IT HAS A GREATER CAPACITY FOR BLOW-OFF THAN ANY OTHER.

¶ The body is made extra heavy throughout of the best steam metal so that it will withstand high pressure.

¶ It is automatic—prompt and positive in action—opens and closes instantly.

¶ Even distribution of load on spring under compression. Compression of spring is made adjustable by means of compression screw threaded in bonnet of valve.

¶ Valve casing is in three parts, making it possible to get at any part of valve easily and quickly.

¶ The spring, spindle and valve proper can be removed without difficulty and without disturbing the outlet connection.

¶ The valve proper is attached to spindle and can be withdrawn with it.

¶ The valve bushing or body seat is made solid, thus preventing the seat from rising under pressure.

¶ The lifting lever with its connecting link and top horizontal lever is very powerful. The movement of the lifting point being vertical throughout, very little effort is required to lift the valve.

¶ A SPECIALLY DESIGNED TESTING NUT MAKES IT POSSIBLE TO TEST THE BOILER UNDER WATER PRESSURE WITHOUT INCREASING THE LOAD ON THE SPRING.

¶ Every valve is carefully tested and fully guaranteed.

¶ Ask for Circular 1-D.

American Steam Gauge & Valve Mfg. Co.,

208-220 Camden Street, Boston, Mass.

New York, 26 Cortlandt St. Atlanta, 835 Equitable Bldg. Chicago, 7-9 So. Jefferson St.

Pittsburg, Frick Bldg. Annex
Montreal, 444 St. James Street.
San Francisco, 247 Pine Street.
Los Angeles, 213 So. Los Angeles Street.

New Equipment

H. N. Johnston, Mooresville, N C., will install a five-ton ice plant.

The Joliet (Ill.) National Bank has had plans prepared for a power house.

The Minnesota Box Company, St Paul, Minn., will erect a new boiler house

E. U. Fordyce, Gainesville, Texas, will establish an ice and cold storage plant

The Plymouth (Mass.) Electric Light Company is planning to enlarge its plant

The Hammond & Knowlton Company, Putnam, Conn., is erecting a new power house.

The citizens of Webster, N. Y., have voted to issue $32,000 bonds for water works.

The City Council, Walthill, Neb., is said to be considering the question of water works.

The Ontario (Cal.) Power Company is contemplating the erection of a substation.

It is reported the Los Angeles (Cal.) Railway Company is planning to build a substation.

The Junction City (Kan.) Electric Railway, Light and Ice Company will enlarge its plant.

Fire destroyed the power house of the Fork River Coal and Coke Company at Middlesboro, Ky.

An explosion partially destroyed the lighting plant of the Wenatchee (Wash.) Electric Company.

The citizens of Thatcher, Ariz, are considering the question of establishing an electric light plant

The Harvey (N. D.) Electric Light and Power Company is preparing plans for its new electric plant.

The Deposit (N. Y) Electric Company is planning to install an additional engine in its plant.

The Gleason Cold Storage Company, Rochester, N. Y., will reconstruct plant recently burned.

The Wabash (Ind.) Water and Light Company will expend about $50,000 in improvements at plant.

The Cosmopolitan Electric Company, Chicago, Ill., will construct a power plant at a cost of $300,000.

Plans have been prepared for the installation of a municipal electric light plant at Herington, Kan.

Plans have been prepared for a new power house at the House of Refuge for Girls, Darlington, Penn.

The Dade City (Fla.) Light and Power Company has been incorporated to furnish light, power, etc.

The Indiana Light, Heat & Power Company has secured a site in Danville, Ind., for a power and light plant.

The city of Rosebud, Texas, will vote on issuance of $20,000 bonds for the construction of water works.

The Polar Star Electric Company, Faribault, Minn., is planning extensive improvements to its plant, it is said.

Plans are being prepared for water works for Parkersburg, W. Va. C. D. Forrer, secretary, Water Commissioners.

The City Council, Millvale, Penn., has authorized the purchase of a new pump for the water works to cost $7,625.

It is reported that the Huntington (N. Y.) Light and Power Company will double the capacity of its plant at Halesite.

New Catalogs

Northern Water Softener Company, Madison, Wis Booklet Water softener 3½x6 inches.

Mason Regulator Company, Boston, Mass. Pamphlet Regulators Illustrated 8 pages, 4x9 inches.

Milwaukee Valve Company, Milwaukee, Wis. Catalog Brass valves. Illustrated, 46 pages, 5x8 inches.

A. Allan & Son, 486 Greenwich street, New York. Bulletin II. Allan anti-friction metal. Illustrated, 32 pages, 6x9 inches

Harris Smokeless Furnace Company, Nashville, Tenn Catalog Harris smokeless furnace. Illustrated, 48 pages 7½x10 inches.

The Foos Gas Engine Company, Springfield, Ohio Catalog No. 20. Gas and gasolene engines Illustrated, 72 pages, 7x9 inches

Buffalo Forge Company, Buffalo, N. Y. Catalog No 197. Fan system of heating and ventilating. Illustrated, 142 pages. 6x9 inches.

The Bird-Archer Company, 90 West street, New York Pamphlet Boiler troubles and their prevention Illustrated, 48 pages, 6x9 inches

Lea Equipment Company, 136 Liberty street, New York. Bulletin G Lea-Degen high-duty turbine pump Illustrated, 16 pages, 6x9 inches.

Smooth-On Manufacturing Company, 572-574 Communipaw avenue, Jersey City, N. J. Instruction Book No. 7, on Smooth-On iron cements, sheet packings and corrugated steel gaskets Illustrated, 96 pages, 4½x6½ inches.

The Jeffrey Manufacturing Company, Columbus, Ohio. Bulletin No 22 Coal tipples and shaking screens Illustrated, 48 pages, 6x9 inches Bulletin No 27 Coal washing plants and equipments. Illustrated, 30 pages, 6x9 inches. Booklet No 57D Conveying machinery for saw mills, lumber mills, etc. Illustrated, 28 pages, 3½x6 inches

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

ENGINEERS wanted to sell the Simplex pipe clamp for stopping leaky pipe joints and the Simplex blow-off valve for boilers in evenings among their fellow engineers on a large commission. Write! The Simplex Engineering Co., 316 Preston St., Phila., Pa.

GEAR CUTTER OPERATOR—A thoroughly high-grade man to take charge of group of Gould & Eberhardt machines. Must have thorough knowledge of gear cutting, both theoretical and practical. Write fully, stating experience, education, age and compensation desired. Box 51, POWER.

WANTED—Salesmen, capable men, to sell a wonderful fuel and labor saving device for boilers. Sells for $50.00. 20,000 in use in United States and Canada. Splendid testimonials. We offer liberal contract. Fine opportunity for a hustler. "Diamond" Power Specialty Co., 236 Fort St., West, Detroit, Mich.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

YOUNG MAN, graduate in electrical engineering at Ohio University, having thorough business education and two years' experience as machinist and electrician in present position, desires change where earnest work will bring advancement. Box 52, POWER.

WANTED—Position as advertising manager. Have had years of experience in building catalogs, booklets, folders, etc., also have a practical knowledge of printing values and all details in connection therewith. I hold similar position at the present time, but for good reasons desire a change. Address A. R. M., 1457 Wilson Avenue, Chicago, Ill.

PROFICIENT STATIONARY ENGINEER, 17 years experience with Buckeye, Corliss and several other types. Technical and practical education, good habits and temperate. I installed several plants, am a good steam fitter, have indicators, can care for dynamos. Will work on trial for one month free to prove my ability as a mechanic. "Proficient," POWER.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—A large pumping station for pumping natural gas. Inquire Pittsburgh Plate Glass Company, Room 1624, Frick Building, Pittsburg, Pennsylvania

STIRLING BOILER TUBES CRACKING? Can stop at once or no pay. Rundown steam plants put in shape. Wm. Fulton Engineering Co., office, 28 N. Canal St., Dayton, O.

INDICATOR CARDS worked out, $1.00 each. Strictly confidential; any questions answered, r.p.m., spring No., engine size, make, etc., required. Jos. J. Hosler, M.E., Eagle Blk., Canton, O.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-examiner, U. S. Patent Office, McGill Bldg., Washington, D. C.

STEAM HEATING REVOLUTIONIZED—We guarantee to furnish you steam at less than your present cost. Our system adapted to any horizontal boiler. For particulars address Isaac Dakin, Box 246, West Newton, Pa.

METALLIC PACKING WANTED—Established packing firm desires sole selling rights for the state of New York of a floating metallic packing that can be applied to any stuffing box without alteration of box or disturbing the rod. "Metallic," POWER.

INVENTOR of a gas turbine desires to negotiate with gas or steam engine manufacturers who have ample facilities for the construction of a working model engine. To a reliable manufacturer who is not afraid of first expense, a first class opportunity is afforded Patents have been granted and those interested can obtain full information by applying to Arthur Sturton, 8 Ellicott Building, Jamestown, N. Y.

For Sale

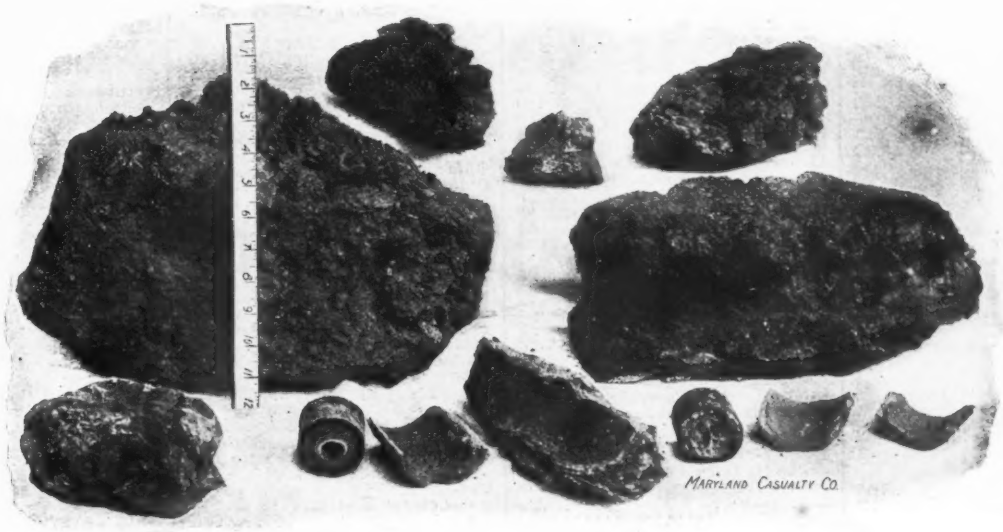
Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

150 HORSE-POWER tandem compound Corliss engine, in good order; 16-ft. wheel; 24-in. face. F. W. Iredell, 11 Broadway, New York.

Alphabetical Index to Advertisers

	PAGE
Alberger Co., A. H.	110
Alberger Condenser Co.	103
Allan & Son, A.	110
American Boiler Economy Co.	106
American District Steam Co.	90
American Engine Co.	112
American Goetze-Gasket and Packing Co.	78
American Injector Co.	83
American School of Correspondence	67
American Steam Gauge and Valve Mfg. Co.	57
American Steam Pump Co.	101
Anchor Packing Co.	78
Anderson Co., V. D.	98
Armstrong Mfg. Co.	80
Ashton Valve Co.	80
Automatic Safety Water Gauge Co.	80
Babcock & Wilcox Co.	103
Ball-Cooley Engineering Co.	110
Ball & Wood Co.	80
Ball Engine Co.	110
Baragwanath & Son, Wm.	99
Barnes Co., W. F. & Jno.	67
Bates Machine Co.	101 and 108



Anything Like This In Your Boilers?

The company that loaned us this photograph tells us that their boiler inspectors find similar conditions in a great many boilers. In fact, from the reports of four of the leading steam boiler inspection and insurance companies, we learn that more than half of all the boilers inspected are defective in various ways which can be traced to impure feed water. It is said that one half of the world doesn't know how the other half live, and we venture to add that even the half that has boilers like this, does not know how dangerous and wasteful of fuel they are, nor how easily the scale can be kept out of them by the use of our "Hot Process System" of Water Purification.

When some people think of a water softening system they have in mind big, expensive tanks, occupying a lot of room, requiring a great deal of skill and attention for their proper care and running up a large bill for chemicals, analyses, labor, etc. In contrast, our "Hot Process System" costs little in the first place and much less than any other system to operate. You should have a feed water heater in any case, and as our system performs all the functions of a feed water heater, you can properly credit the system with the cost of the heater, which enables you to get your softening system at small cost. When it comes to operation, our system does not require chemical analyses nor the services of a chemical expert. Any intelligent workman can adjust the feed of the single chemical employed; and, by the way, the fact that our system treats the water *hot*, saves the expense and trouble of lime, which is employed by other systems. Lime not only costs money, but if it is not correctly adjusted to the impurities in the water, it is apt to introduce more scale forming matter into the boiler than would have come from the raw untreated water itself.

If you want hot water for your boilers, if you are troubled with scale, if you want to keep oil out of your heating system or want to be able to use your exhaust or to conserve it when condensed,—send us particulars and you will promptly get information of such value that you will thank us for having directed your attention to this matter.

Harrison Safety Boiler Works,

17th and Clearfield Sts., 42 **Philadelphia, Pa.**

	PAGE
Beggs & Co., Jas.	94
Berry Engineering Co.	106
Bignall & Keeler Mfg. Co.	81
Binghamton Boiler Compound Co.	85
Bird-Archer Co.	1
Brandt, Randolph	78
Bristol Co.	116
Broomel, Schmidt & Steacy Co.	109
Buckeye Boiler Skimmer Co.	85
Buckeye Engine Co.	111
Burt Mfg. Co.	10
Cancos Mfg. Co.	78
Canfield Mfg. Co.	71
Carey Co., Philip	96
Carpenter & Co., Walter D.	85
Chaplin-Fulton Mfg. Co.	106
Chesterton Co., A. W.	85
Clark Bros. Co.	111
Cleveland Belting and Machinery Co.	70
Climax Smoke Preventer Co.	92
Cling-Surface Co.	65
Cook's Sons, Adam	86
Cooper Co., C. & G.	111
C-O-Two Furnace Co.	92
Crocker-Wheeler Co.	107
Crosby-Steam Gage & Valve Co.	63
Curtis & Curtis Co.	81
Davis Regulator Co., G. M.	104
Dean Bros. Steam Pump Wks.	103
Dearborn Drug & Chemical Works	5
De Laval Steam Turbine Co.	108
De La Vergne Machine Co.	110
Deming Co.	103
d'Este Co., Julian	98
Detroit Leather Specialty Co.	63
Detroit Lubricator Co.	87
Diamond Rubber Co.	77
Direct Separator Co.	94
Dixon Crucible Co., Jos.	85
Du Bois Iron Works	102
Eclipse Feed Water Heater & Purifier Co.	101
Edge Moor Iron Co.	105
Epping-Carpenter Co.	70
Erie Mfg. and Supply Co.	100
Eureka Packing Co.	75
Fisher Governor Co.	106
Fitchburg Steam Engine Co.	113
Foos Gas Engine Co.	109
Fort Wayne Electric Wks.	65
Gardner Governor and Separator Co.	106
Garlock Packing Co.	9
General Electric Co.	112
General Specialty Co.	83
Goubert Mfg. Co.	94
Goulds Mfg. Co.	103
Green Engineering Co.	92
Green Fuel Economizer Co.	99
Greene, Tweed & Co.	87-116
Griffith & Wedge Co.	110
Griscom-Spencer Co.	101
Hammel Oil Burner Co.	92
Harrisburg Pipe and Pipe Bending Co.	100
Harrison Safety Boiler Wks.	59
Hawk-Eye Compound Co.	67
Heine Safety Boiler Co.	104
Hershey Machine and Fdry. Co.	94
Hill Publishing Co.	70 and 88
Hoffman, Geo. W.	110
Homestead Valve Mfg. Co.	79
Hoppes Mfg. Co.	95
Houchin-Aiken Co.	78
Huyette Co., Paul B.	81
International Correspondence Schools	71
Jeffrey Mfg. Co.	91
Jenkins Bros.	73
Johns-Manville Co., H. W.	69
Johnson Co., Henry	78
Keeler Co., E.	105
Kewanee Boiler Co.	105
Keystone Lubricating Co.,	3 and 115
Kitts Mfg. Co.	97
Lagonda Mfg. Co.	84
Lammert & Mann	79
Leavitt Machine Co.	81
Liberty Mfg. Co.	93
Lippincott Steam Specialty & Supply Co.	67
Loew Mfg. Co.	100
Lunkenheimer Co.	82
McClave-Brooks Co.	7
McCrea & Co., James	80
McGowan Co., Jno. H.	103
McLeod & Henry Co.	91
Martin Grate Co.	92
Mason Regulator Co.	80
Mayville Specialty Mfg. Co.	92
Mercer Rubber Co.	76
Minneapolis Steel and Machinery Co.	114
Morehead Mfg. Co.	98
Morrin Climax Boiler Co.	103
Mound Tool and Scraper Co.	67
Murphy Iron Works	92
Myers & Bro., F. E.	104
National India Rubber Co.	78
National Pipe Bending Co.	100
National Tube Co.	80
Neemes Bros.	92
New York Belting and Packing Co., Ltd.	74
Northern Electrical Mfg. Co.	110
Ohio Blower Co.	96
Ohio Brass Co.	79
Ohio Injector Co.	83
Oil Well Supply Co.	104
Oster Mfg. Co.	65
Parker Boiler Co.	105
Patterson & Co., Frank L.	101
Peerless Rubber Mfg. Co.	72
Penberthy Injector Co.	8
Pennsylvania Flexible Metallic Tubing Co.	76
Philadelphia Lubricator and Mfg. Co.	87
Phosphor Bronze Smelting Co., Ltd.	70
Pierce Co., Wm. B.	2
Pittsburgh Gage & Supply Co.	86
Pittsburgh Valve and Fittings Co.	79
Pittsburgh Valve, Foundry and Construction Co.	80
Platt & Co., Jno.	98
Power Specialty Co.	105
Presbrey Fire Brick Works	107
Providence Engr. Works	110
Quaker City Rubber Co.	4
Randle Machinery Co.	108
Reagan Grate Bar Co.	91
Reeves Pulley Co.	63
Reliance Gauge Column Co.	97
Restein Co., Clement	77
Rhoads & Son, J. E.	90
Ridgway Dynamo and Engine Co.	109
Riverside Engine Co.	113
Robertson & Sons, Jas. L.	75
Robins New Conveyor Co.	91
Rust Boiler Co.	105
St. John, G. C.	98
Saginaw Mfg. Co.	91
Salamander Grate Bar Co.	92
Sawyer Belting Co.	90
Schieren Co., Chas. A.	89
Schutte & Koerting Co.	67
Shepherd Engineering Co.	116
Shultz Belting Co.	93
Simplex Engineering Co.	88
Sims Co.	103
Sirocco Engineering Co.	93
Skinner Engine Co.	110
Smooth-On Mfg. Co.	9
Southwark Foundry and Machine Co.	10
Starrett Co., L. S.	116
Steel Mill Packing Co.	75
Stephenson Mfg. Co.	87
Stewart Heater Co.	93
Strong, Carlisle & Hammond Co.	97
Struthers-Wells Co.	109
Sturtevant Co., B. F.	107
System Co.	70
Toledo Pipe Threading Machine Co.	81
Trill Indicator Co.	90
Trimont Mfg. Co.	87
Triumph Electric Co.	107
Triumph Ice Machine Co.	108
Underwood & Co., H. B.	109
Union Steam Pump Co.	101
U. S. Mineral Wool Co.	79
Vanda Co.	76
Vilter Mfg. Co.	110
Vogt Machine Co., Henry	105
Walch & Wyeth	90
Walton Co., F. S.	90
Warren Steam Pump Co.	103
Watertown Engine Co.	110
Watson & McDaniel Co.	97
Watson-Stillman Co.	96
Webster & Co., Warren	61
Westinghouse Machine Co.	113
Wetherill & Co., Robert	111
Wheeler Condenser & Eng. Co.	102
Whitlock Coil Pipe Co.	98
Wickes Boiler Co.	105
Wiederholdt Construction Co.	92
Wilkinson Mfg. Co.	92
Williams & Co., J. H.	70
Williams Foundry and Machine Co.	90
Williams Valve Co., D. T.	94
Wing Mfg. Co., L. J.	104
Worthington, Henry R.	102
Wyckoff & Son Co., A.	63
Yale & Towne Mfg. Co.	65
York Mfg. Co.	108

Classified Index to Articles Advertised

Air Compressors

Deane Steam Pump Co., Holyoke, Mass.
McGowan Co., John H., Cincinnati, O.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Riverside Engine Co., Oil City, Pa.
Union Steam Pump Co., Battle Creek, Mich.
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Arch, Boiler

McLeod & Henry Co., Troy, N. Y.

Arch, Boiler Door

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Wing Mfg. Co., L. J., New York.

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Wickes Boiler Co., Saginaw, Mich.

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Griffith & Wedge Co., Zanesville, O
Heine Safety Boiler Co., St. Louis, Mo.
Keeler & Co., E., Williamsport, Pa.
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Struthers-Wells Co., Warren, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Wetherill & Co., Robert, Chester, Pa.
Wickes Boiler Co., Saginaw, Mich.

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Keeler Co., E., Williamsport, Pa.
Kewanee Boiler Co., Kewanee, Ill.
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Parker Boiler Co., Philadelphia, Pa.
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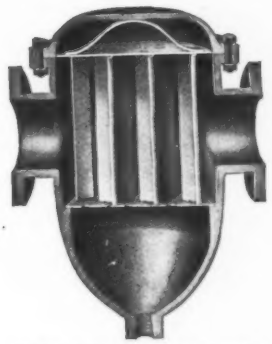

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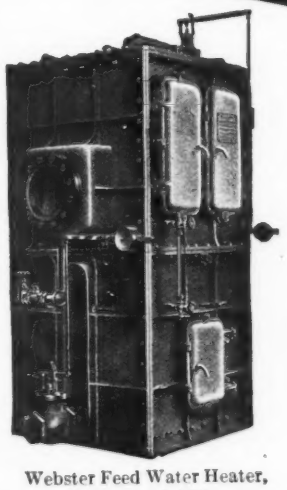

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Booklet 12-S describes the Separators.

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17

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N. Y. Belting & Packing Co., New York.

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Wiederholdt Construction Co., Chicago, Ill.

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Wiederholdt Construction Co., Chicago, Ill.

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McCrea & Co., James, Chicago, Ill.

Clamp, Pipe

McCrea & Co., James, Chicago, Ill.
Simplex Engineering Co., Philadelphia, Pa.

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Liberty Mfg. Co., Pittsburg, Pa.
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Robertson & Sons, Jas. L., New York.
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Cocks, Gage

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Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
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Williams Valve Co., D. T., Cincinnati, Ohio.

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Williams Valve Co., D. T., Cincinnati, O.

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Schutte & Koerting Co., Philadelphia, Pa.
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Baragwanath & Sons, Wm., Chicago, Ill.
Wheeler Condenser and Engineering Co., New York.

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Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

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Vilter Mfg. Co., Milwaukee, Wis.
Watertown Engine Co., Watertown, N. Y.
Wetherill & Co., Robert, Chester, Pa.
Wheeler Condenser & Engineering Co., New York.

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Foos Gas Engine Co., Springfield, O.
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Struthers-Wells Co., Warren, Pa.
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Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Shepherd Engineering Co., Williamsport, Pa.
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Watertown Engine Co., Watertown, N. Y.
Westinghouse Machine Co., Pittsburg, Pa.

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Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Engine Co., Fitchburg, Mass.
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Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Mach. Co., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

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Ball-Cooley Engineering Co., New York.

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Lunkenheimer Co., Cincinnati, O.
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Ohio Brass Co., Mansfield, O.

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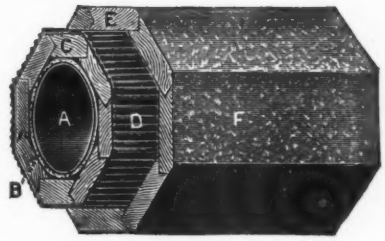

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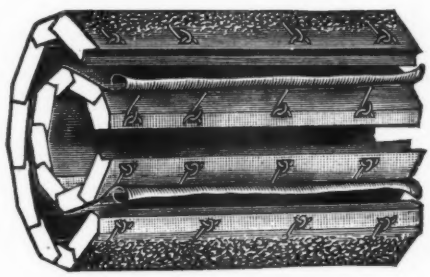

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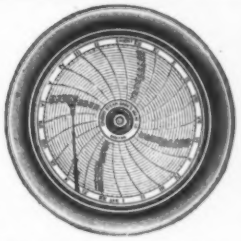

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Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Gages, Vacuum

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Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

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Jenkins Bros., New York.
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Johnson Co., Henry, Jersey City, N. J.
National India Rubber Co., Bristol, R. I.
N. Y. Belting & Packing Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Smooth-On Mfg. Co., Jersey City, N. J.
U. S. Mineral Wool Co., New York.

Gaskets, Copper

Restein Co., Clement, Philadelphia, Pa.
U. S. Mineral Wool Co., New York.

Generating Sets

American Engine Co., Bound Brook, N. J.
Crocker-Wheeler Co., Ampere, N. J.
Foos Gas Engine Co., Springfield, Ohio.
Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

Generating Sets—*Continued.*

Skinner Engine Co., Erie, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Watertown Engine Co., Watertown, N. Y.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Generating Units

Ridgway Dynamo & Engine Co., Ridgway, Pa.

Governors, Pump

American Boiler Economy Co., Philadelphia, Pa.
Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Indianapolis, Ind.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Marshalltown, Iowa.
Gardner, Governor & Separator Co., Quincy, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.

Graphite

Carpenter Co., W. D., New York.
Dixon Crucible Co., Jos., Jersey City, N. J.
Garlock Packing Co., Palmyra, N. Y.

Grate Bars

Reagan Grate Bar Co., Philadelphia, Pa.

Grates

Green Engineering Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Martin Grate Co., Chicago, Ill.
Salamander Grate Bar Co., New York.

Grates, Clinker Cutting

Neemes Bros., Troy, N. Y.
Reagan Grate Bar Co., Philadelphia, Pa.

Grates, Shaking and Dumping

McClave-Brooks Co., Scranton, Pa.
Martin Grate Co., Chicago, Ill.
Neemes Bros., Troy, N. Y.
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Grates, Stationary

Neemes Bros., Troy, N. Y.
Reagan Grate Bar Co, Philadelphia, Pa.

Grease

Carpenter & Co., W. D., New York
Cook's Sons, Adam, New York.
Keystone Lubricating Co., Philadelphia, Pa.

Heaters, Feed Water

Alberger Condenser Co., New York.
Baragwanath & Son, Wm., Chicago, Ill.
Bates Machine Co., Joliet, Ill.
Eclipse Feed Water Heater and Purifier Co., Appleton, Wis.
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Goubert Mfg. Co., New York.
Griscom-Spencer Co., New York.
Harrison Safety Boiler Wks., Philadelphia, Pa.
Harrisburg Pipe and Pipe Bending Co., Harrisburg, Pa.
Hoppes Mfg. Co., Springfield, O.
Kewanee Boiler Co., Kewanee, Ill.
Loew Mfg. Co., Cleveland, O.
National Pipe Bending Co., New Haven, Conn.
Patterson & Co., F. L., New York.
Sims Co., Erie, Pa.
Stewart Heater Co., Buffalo, N. Y.
Webster & Co., Warren, Camden, N. J.
Wheeler Condenser and Engineering Co., New York.
Whitlock Coil Pipe Co., Hartford, Conn.
Wickes Boiler Co., Saginaw, Mich

Heating and Ventilating Apparatus

Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.
Webster & Co., Warren, Camden, N. J.

Heating, District Steam

American District Steam Co., Lockport, N. Y.

Hoists, Electric

Yale & Towne Mfg. Co., New York.

Hoists, Hand

Yale & Towne Mfg. Co., New York.

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Garlock Packing Co., Palmyra, N. Y.
Mercer Rubber Co., Hamilton Square, N. J.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

Hose, Steam and Water

Anchor Packing Co., Philadelphia, Pa.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Mercer Rubber Co., Hamilton Square, N. J.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

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Indicators, Gas Engine

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Hydraulic

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Speed

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Starrett Co., L. S., Athol, Mass.

Indicators, Steam Engine

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Crosby Steam Gage & Valve Co., Boston, Mass.
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Watson-Stillman Co., New York.

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General Electric Co., Schenectady, N. Y.
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Keystone Lubricating Co., Philadelphia, Pa.

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Detroit Lubricator Co., Detroit, Mich.
Greene, Tweed & Co., New York.
Lunkenheimer Co., Cincinnati, O.
Ohio Lubricator Co., Wadsworth, O.
Philadelphia Lubricator & Mfg. Co., Philadelphia, Pa.

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Jeffrey Mfg. Co., Columbus, O.

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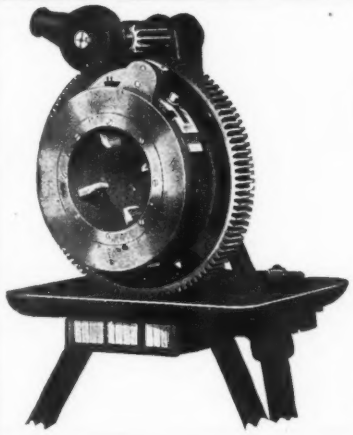

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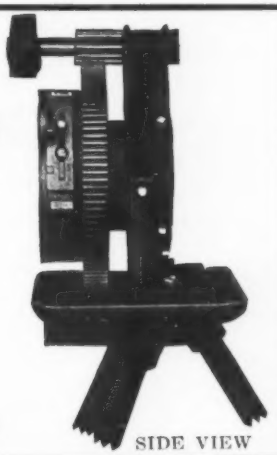

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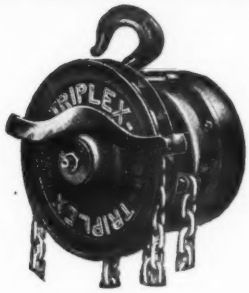

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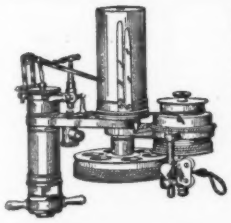

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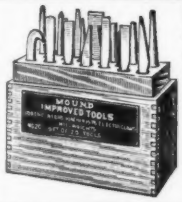

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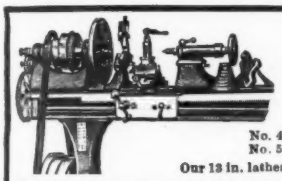

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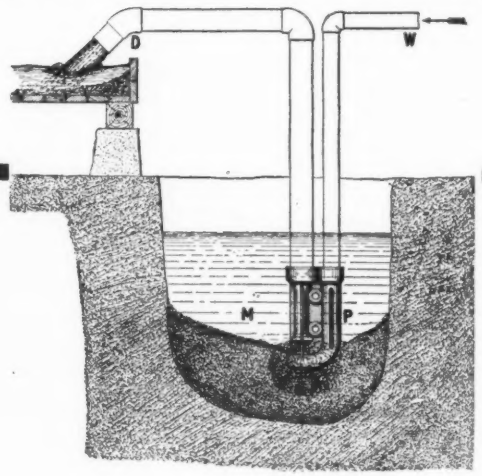

This apparatus is chiefly used for removing sand and other accumulations from wells, etc., and for coal washing. They are operated by Water Pressure, and constructed with small holes at bottom so as to stir up the solid matter to be lifted.

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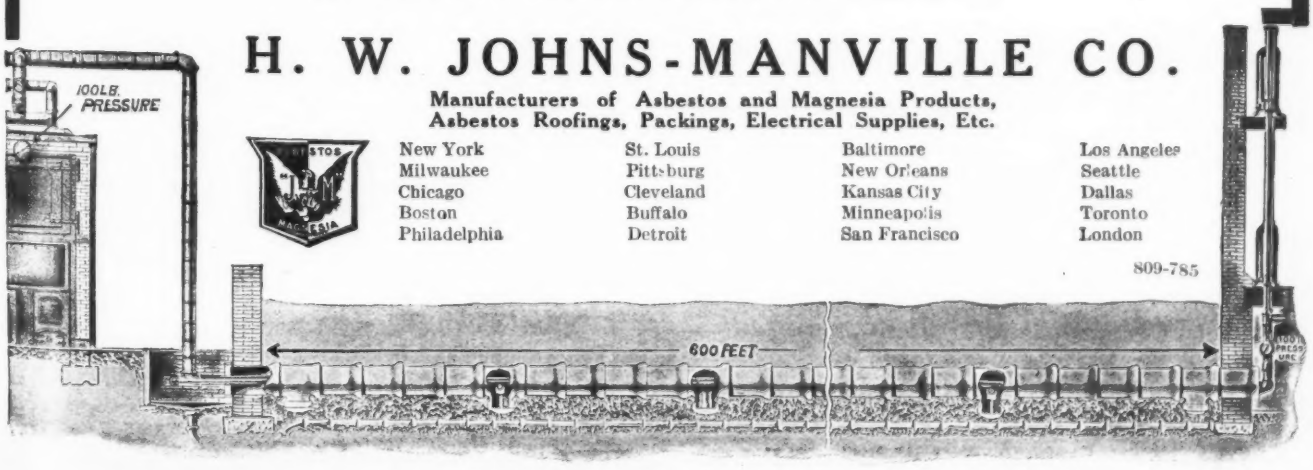

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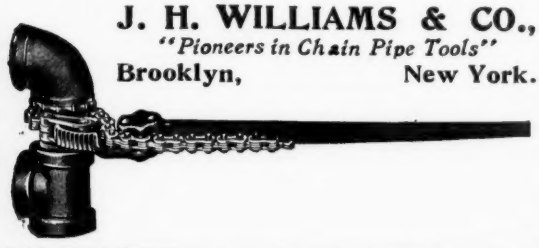

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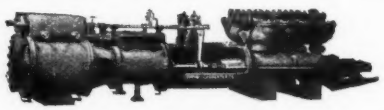

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The pressure and heat cause this packing to vulcanize, filling up all inequalities in the surface and hardening without becoming brittle.

Once properly set Jenkins packing requires no further attention.

Catalog ?

JENKINS BROS.,

71 John Street, New York, N. Y.
133 No. 7th Street, Philadelphia. 226-228 Lake St., Chicago.
35 High Street, Boston. Queen Victoria St., London.

Cobbs High Pressure Spiral Piston and Valve Stem Packing

The Rubber core is made of an oil and heat resisting compound, wrapped with a well frictioned Duck, with an outer cover of fine asbestos, lubricated by our secret process.

It is made round or square, in coil or spiral form especially adapted to withstand heat and high pressure. We guarantee "Cobbs" Packing will pack any rod perfectly tight, as it will not get hard under any degree of heat.

"Cobbs" Packing also furnished in rings at short notice, made of round or square packing.

Indestructible White Sheet Packing

Is without doubt the toughest and most durable High Pressure Sheet Packing on the market. It will stand the highest pressure and extreme heat, making a tight joint when used for Steam, Air, Hot or Cold Water.

It does not dry out or become hard and brittle, but retains its tough elastic qualities, either in or out of service. Ammonia, Liquor, Alkali, Oils or Acids have little or no effect on it, and joints can be broken numerous times without renewing the packing.

Indestructible White Sheet Packing is also made with wire insertion.

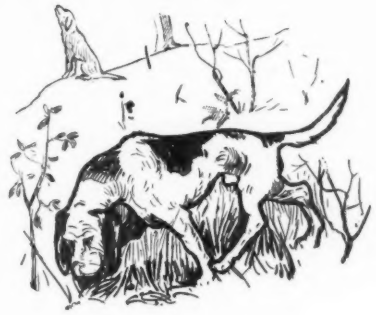
We manufacture a complete line of high class rubber goods, comprising Belting, Air, Fire, Garden, Steam, Suction, Pneumatic Tool and Water Hose Packings, Gaskets, Mats, Matting, Stopples, Special Mould Goods, Interlocking Rubber Tiling, Tubing, etc.

SOLE MANUFACTURERS

New York Belting & Packing Company, Ltd.

91 and 93 Chambers Street, New York, N. Y.

CHICAGO, 150 Lake St.
ST LOUIS, 218-220 Chestnut St.
PHILADELPHIA, 118-120 N. 8th St.
SAN FRANCISCO, East 11th St. and 3d Ave., OAKLAND.
BOSTON, 232 Summer St.
INDIANAPOLIS, 229 S Meridian St.
BALTIMORE, 114 W. Baltimore St.
BUFFALO, 600 Prudential Bldg.
PITTSBURG, 913 915 Liberty Ave.
SPOKANE, WASH., 163 S. Lincoln St.
LONDON, E. C., ENGLAND, 58 Holborn Viaduct.



Pedigree will always tell. You wouldn't take a Pug on a hunting trip—nor would you take a poorly bred Pointer if you could get one with a blue ribbon record.

The point is—in everything the kind must be right and then you must get the best of that kind, and this rule hits Packing just as much as it does dogs.

Genuine Eureka Packing has a pedigree 30 years long. It has won many blue ribbons in the world's largest plants and always gets the points for Right Material, Correct Principle, Expert Construction, Durability, Frictionlessness and Economy.

If you want the packing that gives perfect service for the longest time, under all conditions, try EUREKA, the Packing with a Pedigree.

We also make Cut Ring High Pressure, Water Proof Hydraulic, in coils and rings, Spiral and Red Sheet Packings. *Write for Samples and Prices.*

Eureka Packing Co.

Jas. L. Robertson, President

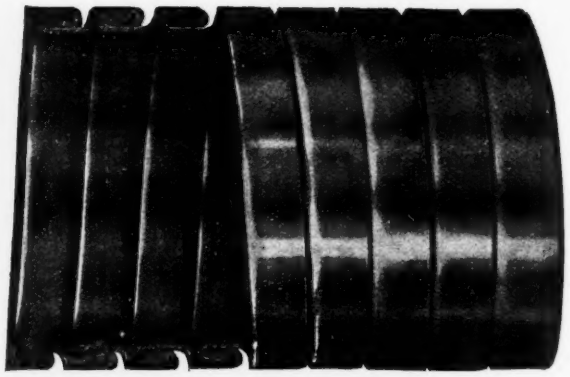
Sales Dept.

46 Warren St., New York

The engineer who does the best work for his employer, does the best work for himself and the surest way to do both is by getting a Robertson-Thompson Indicator and Victor Reducing Wheel. This outfit furnishes accurate data that enables the engineer to get highest possible economy from his engine all the time. Sold at a moderate price, on easy terms.

JAS. L. ROBERTSON & SONS,

46 Warren Street, NEW YORK



Note The Interlocking Edges

which inclosing an asbestos thread make Pennsylvania Metallic Tubing more flexible than rubber hose and as strong as metal pipe.

Sizes ⅛" to 12" for high pressures of steam, gases, compressed air, ammonia, oils and all liquids. Write today.

PENNSYLVANIA FLEXIBLE METALLIC TUBING COMPANY

1305 Arch Street, Philadelphia, Pa.

S. H. COLLOM — H. A. ANSELL

NEW YORK, 86 Warren St. — BOSTON, 71 High St.
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"RED BREAST"

Red Breast Packing

A Standard Red Sheet Packing—Will not crack or harden under any degree of heat; absolutely impervious to the influence of alkalies, oils and Ammonia; positively won't contract or expand; and will withstand the highest pressure.

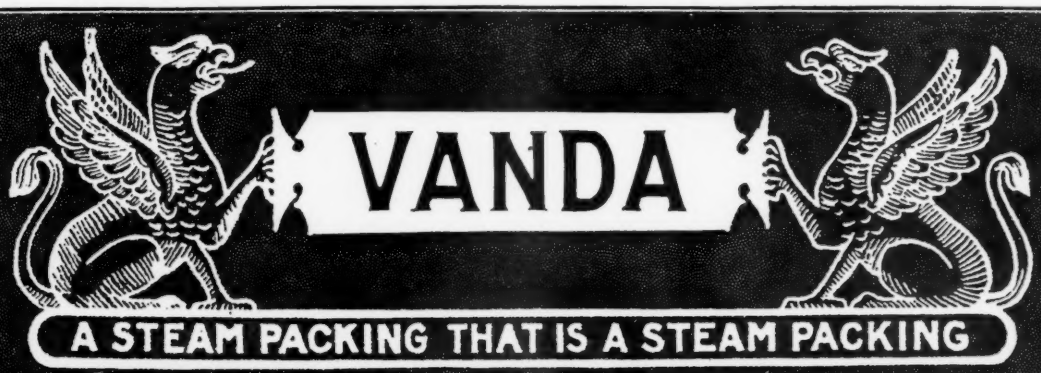
Write for Free Sample

This Packing is better than others—far better—and, better still, is low priced. We will gladly send samples **Free** upon request.

MERCER RUBBER CO.,

Hamilton Square, New Jersey

Branch Offices—Philadelphia, 421 Arcade Bldg. New York, 250 Fulton St. Pittsburg, Pittsburg Rubber Supply Co., 8th and Liberty Sts. Denver, Foster & Taylor, 610 Exchange Bldg., and Chicago, 40 Dearborn St.



A STEAM PACKING THAT IS A STEAM PACKING

TRADE MARK. REG. IN U. S. PAT. OFF.

All Goods Stamped with the VANDA TRADE-MARK will fulfill the claims we make for them.

VANDA SHEET PACKING

THIS PACKING IS THE PIONEER OF ALL COMPOSITION PACKINGS, AND IMITATORS ARE APPEARING IN GREAT NUMBERS. WE THEREFORE, WOULD ESPECIALLY CALL YOUR ATTENTION TO OUR

TRADE-MARK DEVICE STAMPED ON EVERY SHEET

GOODS MADE IN SHEETS ONLY OF 4½' x 4½' AND 4½' x 9', IN ALL THICKNESSES

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H. W. JOHNS-MANVILLE CO., CO-DISTRIBUTORS

ENGINEERS WHO HAVE USED

INDIAN RED SHEET PACKING

Will tell you it has the
STAYING AND RESISTING QUALITIES

It is efficient in every respect
which, in the end, means economy.

A 14 x 28 hanger, like cut herewith, but in colors,
free to any engineer upon request.

The DIAMOND RUBBER CO., AKRON, OHIO.

Complete Diamond Stocks Carried By

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Belmont Packings

"The Big Three."

BELMONT EXPANSION NO. 1. BELMONT HIGH PRESSURE NO. 50. BELMONT HYDRAULIC NO. 8.

Belmont Expansion No. 1.—For ammonia and for steam up to 125 lbs. pressure. The two wedges are independently movable within the casing. By pulling one forward an inch or two, and pushing the other back an equal distance, the break, when the ring is closed, is divided into three parts occurring at different points around the circumference. This feature enables one ring to hold steam or ammonia as well as three rings of any other packing, and makes it invaluable for shallow stuffing boxes. Write for booklet A.

Belmont High Pressure No. 50.—The *only safe packing* for high pressure, high speed and superheated steam. Made with asbestos wedges, special rubber compound back and casing, and lubricated by high test compound in connection with best Ceylon graphite. Nothing to char or become brittle. Highest steam pressure and superheat easily resisted. Outlasts others, keeps rods in perfect trim. The *only modern high pressure packing* on the market. Write for booklet B or booklet H (special booklet on locomotive packings).

Belmont Hydraulic No. 8.—A *Modern Hydraulic Packing* for pump rods and plungers—not for steam. *See the stitching!* This packing is stitched through and through crosswise; cannot *twist*, *swell* or *pinch*. Braided flax core, casing of finest cotton duck and rubber. Especially valuable for alkaline or sulphuric acid mine water. Write for booklet C.

A full line of other packings for every known purpose. Large general catalogue free on request. Sample ring of any packing free. Fill in coupon stating kind wanted.

Salesmen Wanted.—To call at power plants, pumping stations and engine rooms and sell BELMONT PACKINGS and Specialities. Particularly attractive proposition for manufacturers, agents and engineers in territory not already covered.

Clement Restein Co., Phila., Pa.
Gentlemen:—Send me a sample ring of .....

Name .....
Address .....
Firm name .....
No. engines..... No. pumps.... No. boilers....
High or low pressure .....
Packing now in use .....?

CLEMENT RESTEIN CO.

133 NORTH SECOND ST., PHILADELPHIA, PA.

The Only Packing

For Scored and Worn Rods

ZENA

is tough, pliable, elastic and will meet the most exacting requirements of high-speed engines and plunger pumps. Write today.

RANDOLPH BRANDT,
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"SAFETY"

PLASTIC METALLIC PACKING

For Steam, Water, Air, Gas, Hydraulic Machines, Valves, Etc.

Guaranteed to stand Steam Temperature up to 550° F. and Hydraulic Pressure to 5000 lbs. per square inch.

Highest Award World's Fair, St. Louis.

Send for **FREE SAMPLE** and particulars.

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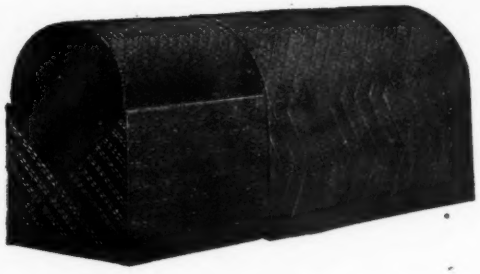
STEEL MILL PACKING CO., Detroit, Mich., U.S.A.



BLACK SQUADRON

THE FOUR WEDGE PACKING
IT WORKS
LIKE THE UNIVERSAL CHUCK

It's only natural that the **4 Wedge Packing** should adapt itself more thoroughly to the irregularities of a piston rod, than the old-fashioned solid or two wedge designs. Like the **Universal Chuck** it responds perfectly to pressure from the gland nuts. No wrench is needed, you can tighten **Black Squadron Packing** more than enough with the fingers. The **materials** are as superior as the design and workmanship, that's why it **lasts,** and never, under any circumstances, cuts a rod. Every particle impregnated with our special lubricating compound. Keeps rods in perfect condition. Illustrated booklet free on request, also copy of "The Engineer," a handbook of valuable power house and engine room data. Don't wait—write now.

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PHILADELPHIA, PA.
10 Oliver St., Boston, Mass. 525 Third Avenue, Pittsburg. Pa.
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Conforms To Every Irregularity

of the flange. Thus Goetze's Elastic Copper Gaskets can be used with perfect results on raw or unmachined surfaces. And they can be used over and over.

They make good in places where all other packings have failed. Save steam and fuel, and stand all pressures, changes of temperature and superheated steam. Shall we go into details? Writes for samples.

American Goetze-Gasket and Packing Co.
525 East 149th St., New York.

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NATIONAL INDIA RUBBER COMPANY
FACTORY, BRISTOL, R. I.
BRANCHES: 42 Broadway, New York. 84 Lake St., Chicago.
140 Essex St., Boston. 37 Hopkins Pl., Baltimore.
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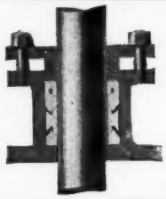
Every New Trial Means A New Customer

That's why we are so anxious to have you test Johnson's Packings. Write for the catalog.

THE HENRY JOHNSON COMPANY,
175-187 GATES AVENUE, JERSEY CITY, N. J.



No Special Stuffing Boxes

Law Packing fits the stuffing box you are already using and can easily be installed by any mechanics. *WRITE TODAY.*

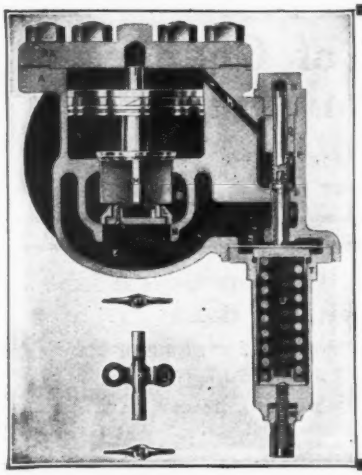
Houchin-Aiken Company,
Sole Manufacturers,
113-121 Fifty-Third St., Brooklyn, N. Y.

The World's Greatest Sheet Packing Is

"THURIL"

It can be used repeatedly as often as 40 times.

THE ANCHOR PACKING CO.
Philadelphia, Pa.



Simplicity and Accessibility

of parts of the Collin Steam Pressure Regulating Valve contribute to its uniformly satisfactory operation.

Its design will instantly appeal to practical men. Either the main valve or controlling valve can be taken out as units without disturbing other parts.

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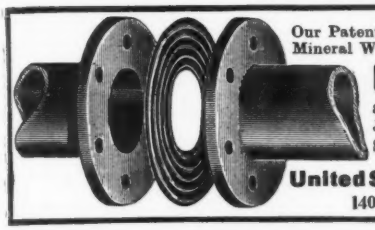

Our Patented Mineral Wool **Pipe Covering and Copper Gaskets** Save Steam and Make Absolutely Tight Joints. Best and Cheapest. Samples Free.

United States Mineral Wool Co.
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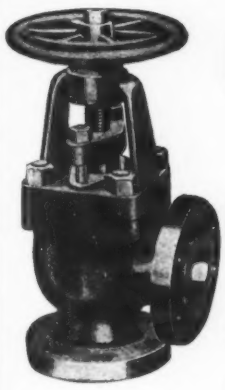

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EDWARD VALVE

For High Pressures, Superheated Steam and Water.

THE LAMMERT & MANN
Oil Dash Pots for Corliss Engines, Gas and Gasoline Engines.

LAMMERT & MANN,
ENGINEERS and MACHINISTS,
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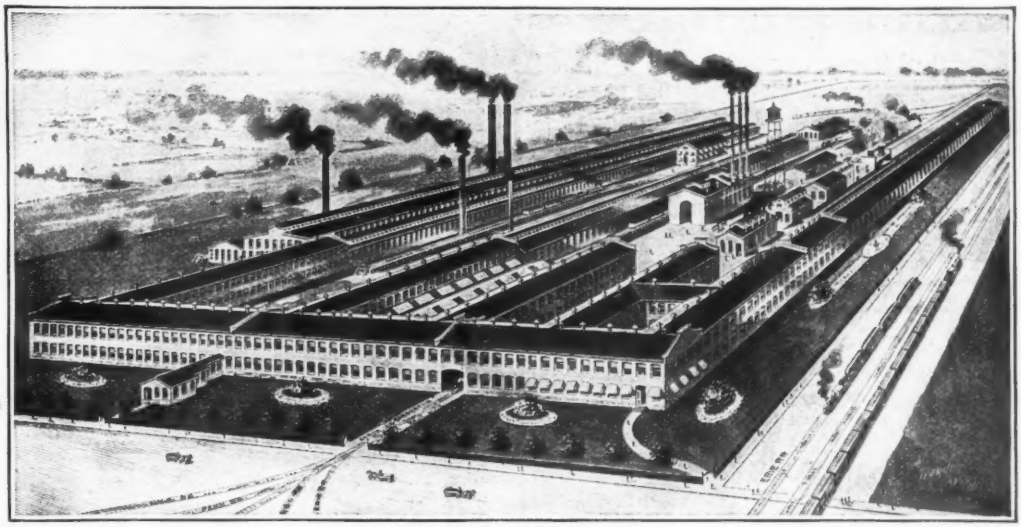
Freedom From Friction

lends long life and liberal usefulness to Homestead Valves. Booklet?

Homestead Valve Mfg. Co.
Brass Founders. Pittsburg, Pa.

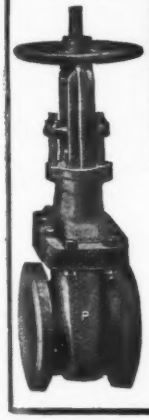
PITTSBURGH IRON BODY GATE VALVES

have been thoroughly tested under the most severe conditions known and have proved that they work under all pressures with less wear on the faces of the discs and seats than any other valves made.



WORKS, BARBERTON, O.

ALWAYS SPECIFY **P** VALVES AND FITTINGS.



ALWAYS SPECIFY **P** VALVES AND FITTINGS.

They are made standard for 150 lbs. and extra heavy for 250 lbs. working pressures. They can be furnished screwed, flanged or hub end; with by-pass, spur or bevel gearing and are suitable for steam, gas or water. They are made with outside screw and yoke or non-rising spindles. We have many thousands of them in use in all parts of the country and have never had a complaint or a valve returned.

PITTSBURGH VALVE & FITTINGS COMPANY,
General Offices and Works: BARBERTON, O. We Manufacture all kinds of Valves and Fittings.

Is It Policy to Sacrifice The Harmony Of Your Entire Plant Through Careless Installation of Valves?

With wide-awake, progressive business men, **positively no!**

With such men no pipage equipment but the best will pass **—absolutely none but the best at the start!**

A plant equipped right at the start will remain right! A plant equipped right at the start will create safety and satisfaction to all concerned!

Every valve and every piece of pipage equipment made by us is not only right at the start, but IT'S RIGHT FOR ALL TIME! Tuyeres, Tuyere Cocks, Regulators, Traps, Etc., Etc. Send for Catalogue.

PITTSBURGH VALVE, FOUNDRY AND CONSTRUCTION COMPANY

PITTSBURGH NEW YORK BOSTON
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Regardless of Changes in the Initial Pressure

The MASON REDUCING VALVE keeps the pressure at exactly the required point. Write for a catalog.

The Mason Regulator Co. . . Boston, Mass.

A Boiler Without an Accurate Gage is Like a Watch Without Hands

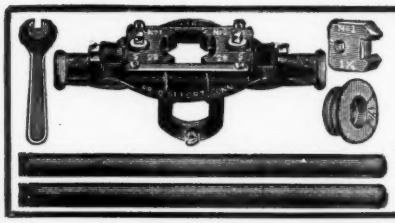
it *may* be working all right but you've no means of knowing. The Ashton is accurate. Write.

The Ashton Valve Company, Boston, U. S. A.
New York St. John's House, London, Eng. **Chicago**

Stulp Automatic Safety Water Gauge

Approved by the U. S. Supervising Inspectors of Steam Vessels and used by the Government and by the largest plants, steamship and transportation companies. *Write.*

THE AUTOMATIC SAFETY WATER GAUGE CO.
Fred J. Stulp, Prop. MUSKEGON, MICH.



STOCKS AND DIES
PIPE MACHINES,
PIPE CUTTERS,
VISES.
Manufactured by
The Armstrong Mfg. Co.
287 Knowlton St.,
BRIDGEPORT, CONN.

PERMANENTLY LEAKLESS JOINTS
Are Made By
"BALLWOOD"
Welded Flanges

They are made of the same grade metal as the pipe and are welded in such a way that they become integral parts of the pipe, expanding and contracting with it. *Circular* 104?

The BALL & WOOD CO.
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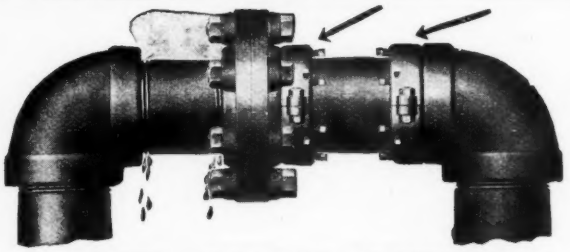
BUILDERS OF BALLWOOD ENGINES



OUR GUARANTEE

The Simplex Pipe Clamp is absolutely guaranteed to make the worst leaky joint absolutely and permanently tight. You can have 30 days in which to test this guarantee—FREE. Write

THE SIMPLEX ENGINEERING CO.,
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CAN'T YOU SEE

that a Brass-to-Iron contact prevents corrosion?

"KEWANEE" UNIONS

have brass thread-piece and malleable iron nut and tail piece. You can therefore disconnect "Kewanee" Unions as often as you please. Write for the other reasons why "Kewanee" Unions lead.

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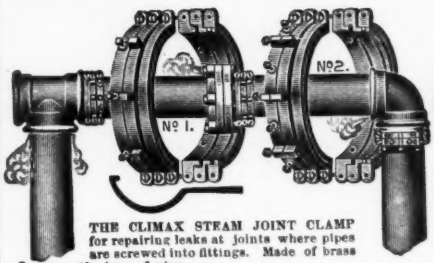
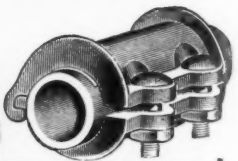


THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.



THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ⅛ in. to 12 inches.

PIPE REPAIRS FOR ANY CONDITION

Send for Catalog of
STEAM SPECIALTIES
JAMES McCREA & CO.,
MANUFACTURERS,
61 West Washington Street, Chicago.

ONE MAN POWER

"TOLEDO NO. 3"

is all that this machine requires to thread pipe from 4½" to 8" inclusive.

The "Toledo" weighs but 155 lbs. and can be carried to the work, thus saving a great deal of time and labor. Write.

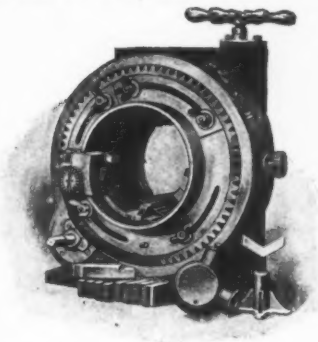
THE TOLEDO PIPE THREADING MACHINE CO.
TOLEDO, OHIO,

Follow the Lead of the Best Plants

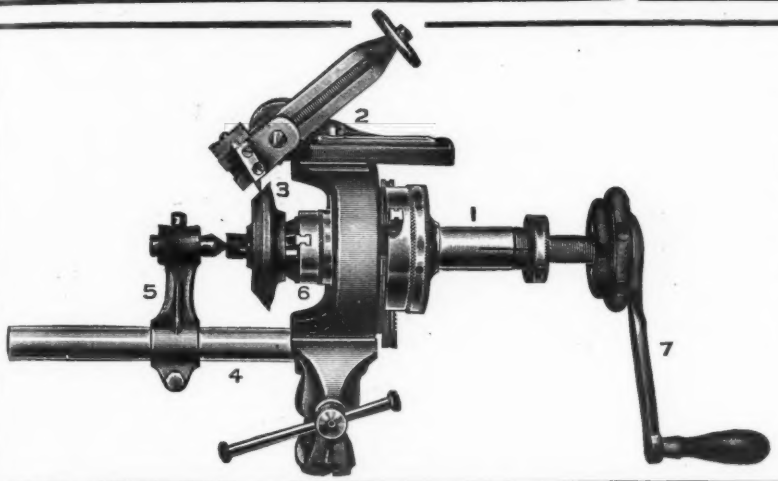
and you will install the

Forbes Patent Die Stock,

cut and thread more pipe at less cost and with greater ease than ever before. Write.



THE Curtis & Curtis Co.
85 Garden Street,
BRIDGEPORT, CONN.



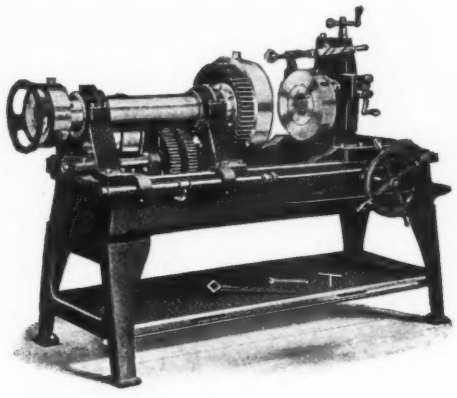
There is no good reason for getting along without a **DEXTER VALVE RESEATING** Machine.

They pay for themselves—so "can't afford it" is no reason for not having one.

You can have a machine thirty days, try it all you want to, reseat your leaky valves on the pipe, fix up those discarded valves, try the machine under all conditions, then return it if you don't care to keep it.

Catalog P illustrates these machines.

The Leavitt Machine Co.,
Orange, Massachusetts, U. S. A.



STEP

into most any shop where several makes of pipe machines are installed, and if any are in use, they are B. & K. The workman prefers to run the B. & K. machines because they are easy to operate and always make good threads.

Bignall & Keeler Mfg. Company
Edwardsville, Ill.

You May Never Be Scalded

with live steam released by a breaking gauge glass but the chances are that you will if you don't discard the old fashioned water gauge.

The "P.B.H." Quick Closing Water Gauge

is provided with chains long enough to assure your safety when a glass breaks. This is but one of many equally valuable features.

Circular anyway.

Have one Free on 30 Days' Trial

The Paul B. Huyette Co.,
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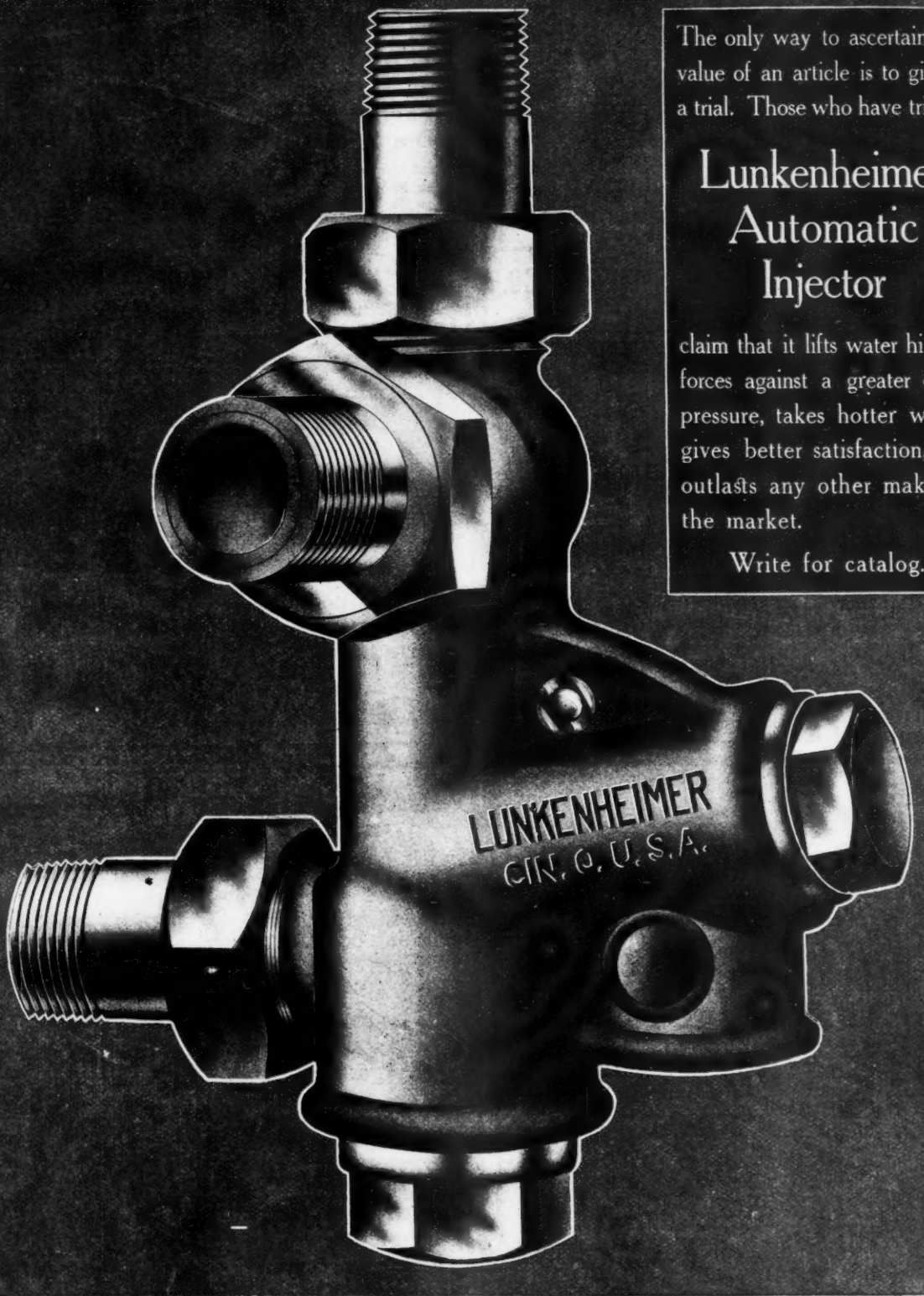


The only way to ascertain the value of an article is to give it a trial. Those who have tried a

Lunkenheimer Automatic Injector

claim that it lifts water higher, forces against a greater over-pressure, takes hotter water, gives better satisfaction, and outlasts any other make on the market.

Write for catalog.

5

The Lunkenheimer Company

Largest Manufacturers of High Grade Engineering Specialties in the World

General Offices and Works, Cincinnati, Ohio, U.S.A.

Branches: New York, 66-68 Fulton St.; London, S. E., 35 Great Dover St.; Chicago, Lake and Dearborn Sts.

A Powerful Little Device for Elevating, Conveying and Transporting Liquids—

The Garfield Ejector

Cannot be beat for raising water from deep wells, mines or pits, filling or emptying tanks, raising or transferring liquids, etc.

Note the straight pipe connections making it desirable for elevating water from deep driven or drilled wells.

Positive in Its Work and Nothing to Get Out of Order

You cannot afford to be without it. Write for complete description. Large Catalog sent free.

The OHIO INJECTOR CO.,

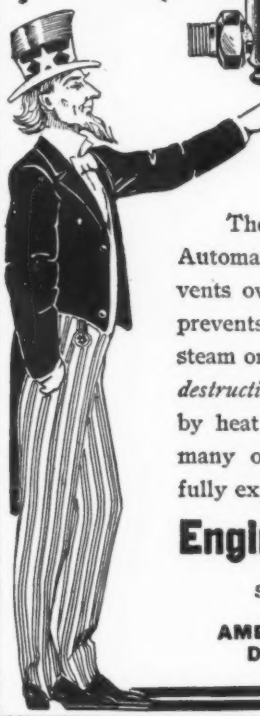
The World's Greatest Injector Manufacturers,

WADSWORTH 110 Main St. OHIO, U. S. A.

No Freezing Here

The Drip Cock prevents it

U.S. Automatic Injector



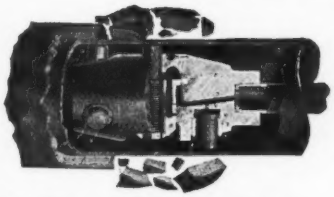
The Drip Cock of the U. S. Automatic prevents freezing; prevents overheating of suction pipe; prevents jet "liming up" when steam or check valve leaks; *prevents destruction of hose on traction engines* by heat from hot water, and has many other exclusive advantages fully explained in our

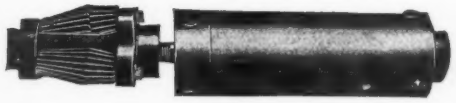
Engineer's Red Book

sent free on request.

AMERICAN INJECTOR CO.
Detroit, Mich., U. S. A.

WE MAKE THE BEST CLEANERS THE WORLD EVER SAW.





The "Torpedo" Fire Tube Cleaner.

The "TORPEDO" is the best fire tube cleaner because:

1st. It travels with triple the speed of any other cleaner (over 11,000 vibrations per minute). The more frequent the raps the lighter can they be, especially when nicely cushioned by both the piston and centering lugs as in the "TORPEDO."

2d. It is automatically centered in the tube. That is, there is no "wobbling" of the cleaner body in action. The stroke is then the same in every direction. Without centering, a cleaner can not use a definite regulated stroke. If the body is on the bottom of tube the stroke must be long enough to reach the top, but it is then TOO LONG on its lower stroke. In such a case it attempts to strike beyond and make a hole in the tube on all its downward strokes, and such a machine will likely stretch the tube.

3d. Simplicity means long life. The "TORPEDO" outside of the six lugs which have *only* to hold the cleaner centrally in the tube, has only one working part. This is the piston with its vibrator directly in its center. "TORPEDO" cleaners have cleaned over 50 boilers and showed little or no signs of wear. Read our folder No. 30. "How to Tell a Good Fire Tube Cleaner."

The "Demon" Straight Tube Cleaner.

The "DEMON" straight cleaner is unequalled for all straight tube boilers because:

1st. It is the only cleaner that uses water pressure directly upon rotary pistons, all others using the turbine principle.

This results in a far more powerful motor, and a greater torque amply sufficient to drive a non-centrifugal head. In other words the cutters are held out in a fixed non-yielding manner so as to attack the scale positively and crush it rapidly under the high twisting power of the "DEMON" motor.

2d. Because of the non-yielding character of the cutter head all scale must be removed down o the iron.

Patches of scale cannot be skipped over as with a turbine cleaner relying upon centrifugal action only.

3d. The "DEMON" can never injure a tube even when allowed to run indefinitely in one spot.

4th. Every machine is given a brake test and must operate at 300 lbs. pressure before leaving factory and it then goes forward with our guarantee to save 50% in time and 3% in fuel over any other cleaner in existence.

Send for folder No. 54.

The "Demon" Curved Tube Cleaner.

The "DEMON" curved tube cleaner solves the problem of rapidly and quickly cleaning all Stirling or other curved tube boilers better than anything else because:

1st. It has the same powerful piston type of motor as described under the head of the straight "DEMON."

This powerful motor means it can keep up a high speed of cutter head when working against the scale.

Careful tests show that the turbine cleaners maintain in the tube only 20% of their speed when running light outside of tube. The "DEMON" maintains 80%.

2d. The cutter head as a whole just fits a tube when clean. In the turbine all the cutter arms are thrown out by the weak centrifugal action only and can thus easily skip over scale. With the "DEMON" two of the cutter arms are non-yielding, the third yielding sufficiently to pass the bends and flats. This head removes the hardest scale down to the iron.

3d. The "DEMON" cleans the curved portion of the tube which so many cleaners only partially clean leaving the tube to burn out at the bend.

Send for folder No. 56.

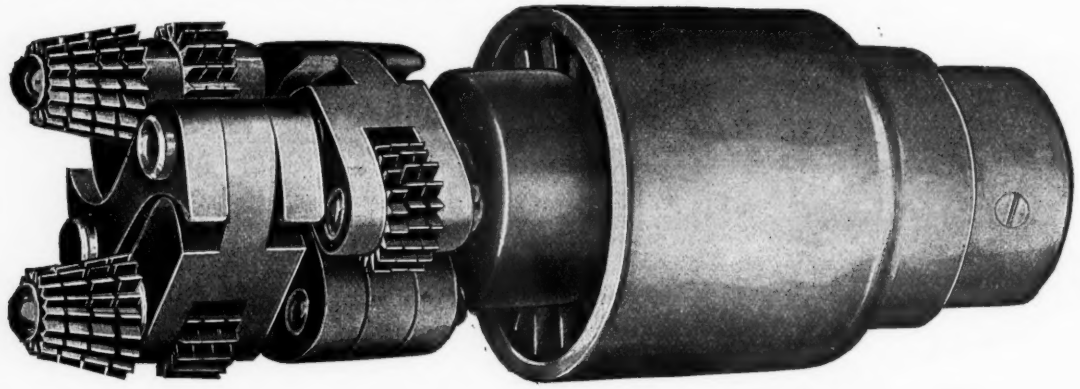
Write for a cleaner on free trial.

The General Specialty Co., 887 Niagara St., Buffalo, N. Y.

N. Y. Representatives: J. B. Hackett Co., No. 5 Beekman St.

ANY SCALE IN YOUR ECONOMIZER TUBES?

Economizers don't economize if the scale within the tubes is neglected. Scale checks transfer of heat to the water as effectively as soot insulates the tube from the outside. And in most plants, scale is just as sure to form. Wherever it is found, a thorough cleaning at regular intervals will save enough heat to make efficient cleaning apparatus a profitable investment.



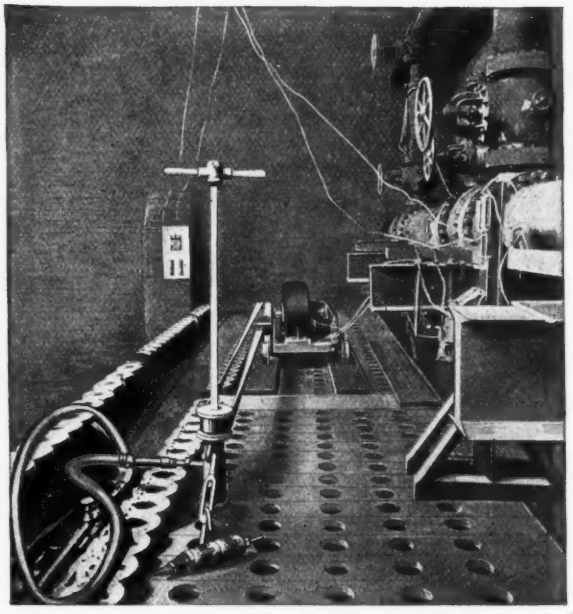
THE WEINLAND WING HEAD TURBINE CLEANER

Is the most efficient Turbine Cleaner ever made by any one. This type is extremely popular, does wonderful work and is amply strong for hard knocks and severe use. If scale is very heavy or extremely hard you can *save time and money by using*

THE WEINLAND MECHANICAL CLEANER.

It will clean tubes even tho they are chuck full of lime, and it is the only Cleaner made that will. Consult us about your needs, we are experts and can give you disinterested advice. We sell or rent machines or clean your boilers, economizers or condensers by contract.

Write for book
"Boiler Scale and Its Removal."



Weinland Mechanical Cleaner at Work on the Economizers of the Hammond Packing Company, Chicago.

THE LAGONDA MFG. CO., Springfield, Ohio.

Makers of Lagonda Automatic Cut-Off Valves, Reseating Machines and Tube Cutters.

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[73]

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All Forged Steel
Case-Hardened

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The Movable Jaw Extends Outward Instead of Toward the Handle, Therefore The Larger the Nut the Longer the Leverage

THREADS IN BOTH NUT AND JAW ARE ROUNDED THUS PREVENTING STRIPPING

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Let Us Analyze Your Scale

Then we will show you how Pyramid Boiler Compound will keep your boilers clean and efficient. Write us.

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BINGHAMTON, NEW YORK.

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SPEND FIVE CENTS

a gallon to graphitize your lubricating oil with **Graphlo.** Your oil will then give better service and last twice as long. No change required in your present oiling system. *Circular?*

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Imitations do not, but dealers buy them cheaper—you know!

Two Tools In One
The COMBINATION
(TRADE MARK REG.)
A SCRAPER and BRUSH Combined.

The scraping edges are *chilled*. The *Protected Spring* acting *equally* on each arm will *never* ausel. Reliable dealers all have the genuine if not, send to

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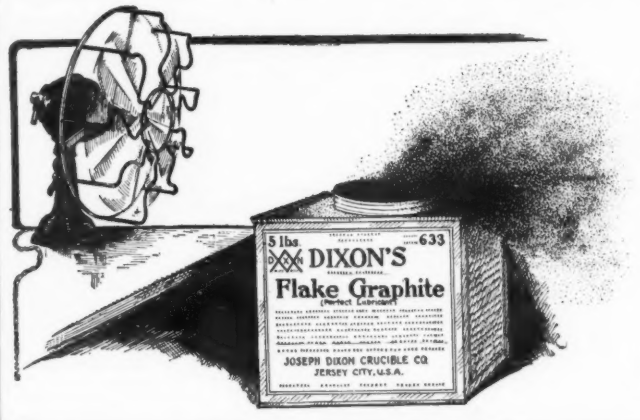

Make The Best Oil Better By Adding A Little

Dixon's Flake Graphite

It makes a wonderful increase in the friction-lowering capabilities of either grease or oil, lengthens life of bearings, saves power, and prevents cutting and scoring in cylinders. Ask for free sample Can 94-C.

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What One Reorderer Thinks

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The Buckeye Boiler Skimmer Co.,
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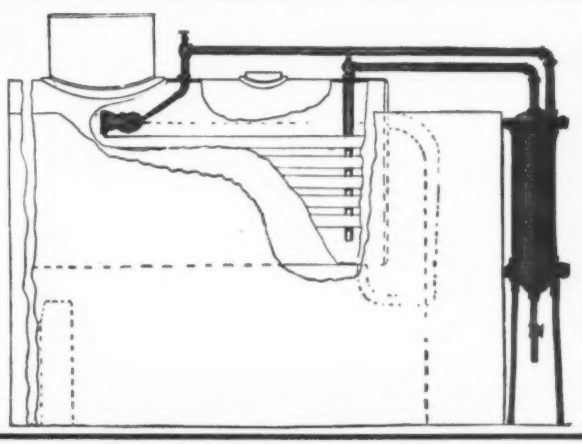
Gentlemen:

Please enter our order for another one of your BUCKEYE FLOATING SKIMMERS, to be a duplicate of the last one.

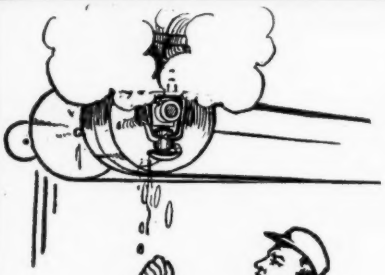
We installed two of your Skimmers last September, and think a boiler not complete without one of them.

Yours truly,
MONTEREY COAL COMPANY,
Per A. J. Watson, Gen'l. Supt.



Buckeye Boiler Skimmer Co.

South End, Toledo, Ohio.



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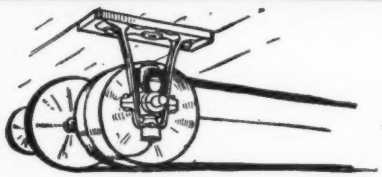

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Nothing Worse I Can Imagine

The only Genuine ALBANY GREASE has this trade mark on every package. Look and ask for it.

Send for FREE sample cup and can of "Albany Grease," giving size of tap for cup, depth of oil hole from top of cap to journal, where to be used and firm's name.

MADE ONLY BY
ADAM COOK'S SONS,
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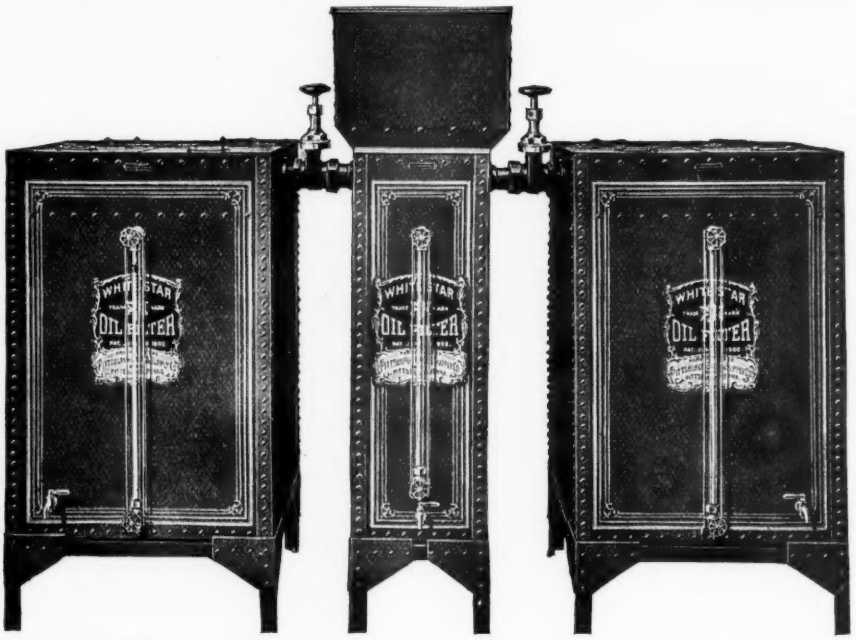
WHITE STAR OIL FILTER

MULTIPLEX TYPE—Used exclusively in oiling systems of the largest capacities.

Will take care of any amount of oil.

Nothing too large.



Successfully employed by the Lackawanna Steel Co., Buffalo, N. Y. on 48,000 h.p. gas and Steam engines and others.

Our catalog "D" treats fully the subject of Engine Lubrication—Send for it.

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Detroit Improved Standard Lubricator

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of our 337 different styles and sizes of sight-feed lubricators will fill any requirement you may have.

When ordering, insist on getting the genuine Detroit.

Write for a catalog of the most complete line of oiling devices for all purposes.

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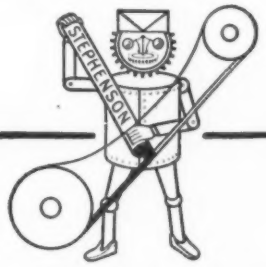


THE AFTER EFFECTS ARE PLEASANT

Don't waste good belts and lose valuable power. **STEPHENSON Bar Belt Dressings** contain no Rosin nor any other ingredients injurious to Belting. Our **RED Label** and **GREEN Label Brands** are two entirely different and distinct preparations. No **one** kind of Dressing is good for **all** Belts—you know that. **STEPHENSON Dressing** not only prevents slipping and gives full speed from slack belts, but **the after effects are pleasant**—it KEEPS those belts in good condition and greatly prolongs their life.

This means a saving in BELTING, which is an important item when figuring the year's expenses.

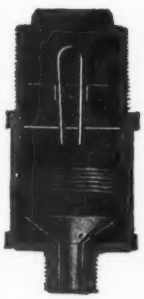
RED Label Brand for Leather belts;
GREEN Label for Rubber and Canvas.

Your protection against substitution is **The Man with the Cog-Wheel Face** on each Pound Stick.

Of Dealers everywhere, or

STEPHENSON MFG. CO.
ALBANY, N. Y.

The "Philadelphia" Grease Cup



Automatic application of grease to the bearing without the use of spring compression. : : : :

Nature Supplies the Feeding Force in the Form of Compressed Air. : : : : : :

With many thousands of the "Philadelphia" Grease Cups in successful operation, on machinery of almost every description, we offer a system of lubrication which, for simplicity, cleanliness, economy, reliability and efficiency has no equal.

The "Philadelphia" Cup is not merely "as good as any other:" IT IS THE BEST, and we are prepared to prove our claim for actual superiority. There are more reasons for its practical success than we have room to mention here.

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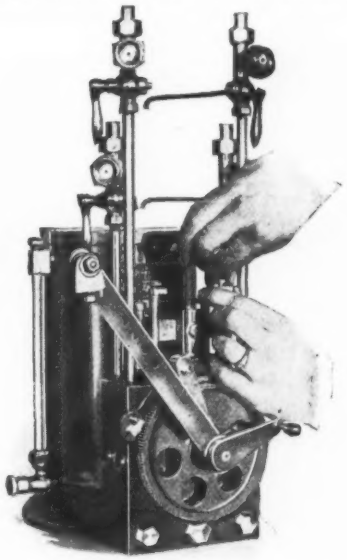
The Philadelphia Lubricator & Manufacturing Co.
The Bourse (Exhibition Dept.), Philadelphia, Pa.

Each Feed Regulated Independently



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30,000 engineers have bought Tulley's Handbook. For fun? For entertainment? No! For business! For the practical facts on its pages; for the help it gives in the day's work

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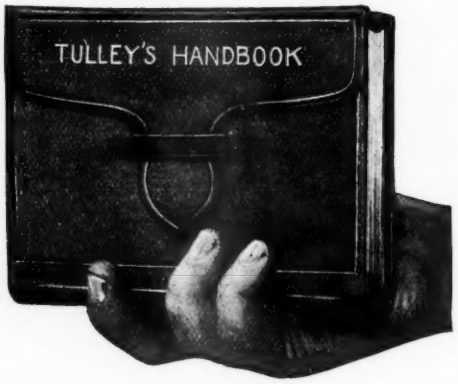
what no other book on earth does—it covers the whole field of steam and electrical engineering clearly, plainly, practically, concisely. It deals in facts and figures that every engineer should know or have close at hand for reference.



It Does Not

talk in foggy language. It does not include any foolish theories. It does not contain algebra, Latin, Greek nor the 'ologies nor 'isms. It does not shoot over the heads of practical engineers.

Picture in your mind a fine leather bound book of more than 1,000 pages, each page chockful of useful information or illustrations that help to clear up knotty points. Imagine yourself up against one of the thousand and one problems that confront an engineer, or with the license examination facing you or with something in your mind upon which you want special information that will enable you to save time and money or promote the efficiency of your plant. Picture yourself with Tulley's Handbook within reach when those points come up. Do you know that you can turn to the complete index, find your subject and then be assured of finding complete and authoritative information upon *your* problem? Such a book *must* hold a value for you far beyond its price.

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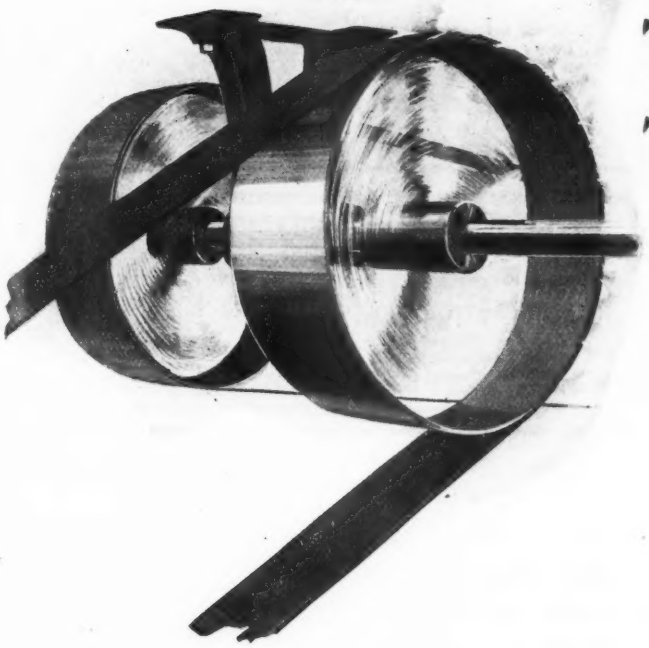

The More A Belt Slips The More It Will Slip

Because of the friction heat, burning and hardening the leather.

Otherwise a little slipping might save broken belts and lacing, and increase their life.

Belt dressings of more or less merit have been on the market for some time--some hold with such tenacity that you might as well use an adhesive cement that has to be torn off the pulley as the belt leaves it, generally taking a layer of the belt with it; some are made by people who know nothing and care less about the destructive chemical action of their dressings on leather.

It's only a leather expert and chemist who is able to make just the right thing for the job, all things considered. This fact induced the Chas. A. Schieren Company to manufacture FLYFOOT BELT DRESSING.

"Flyfoot," as the name implies, has the property of holding a belt to a pulley by suction, allowing the belt to lift off without adhesion as the pulley revolves.

"Flyfoot" has no chemical effect on the leather, only closes the pores and prevents drying out, in this way preserving it.

You know that a rolling mill belt must not slip. Well, "Flyfoot" is the best dressing for rolling mills.

Send $2.00 for a 5 lb. tin; send it back if you don't want it, and get your money by return mail.

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ESTABLISHED 1868

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RHOADS LEATHER BELTING

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A Superior NON-POISONOUS Jointing Material of Metallic Composition; for FLANGE and SCREW-JOINTS of every description on Steam, Water, Air, Gas, Ammonia, etc. UNITES TWO METALS AS ONE. Cheaper, more efficient than red lead—no waste in its use.

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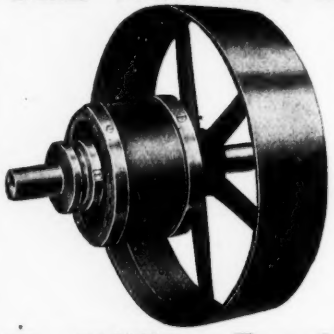

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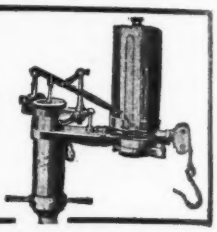
The Williams Foundry & Machine Co.

Successors to the Akron Clutch Co. Akron, Ohio.

There's No Just As Good

although there are indicators which cost $50 more than the Trill. Ask for a Trill on trial.



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CENTRAL STATION HEATING.

Write for valuable information.

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Belting Logic—If best Leather Belting costs per sq. ft. $1.00, best Rubber Belting 60c., and best Stitched Canvas Belting 40c., and with Leather showing 25% and Rubber 50% of the strength of **Best Stitched Canvas Belting,** wouldn't it be good policy for you as a practical man to investigate the merits of our product? Send for Book "C."

SAWYER BELTING COMPANY, CLEVELAND, OHIO.

OXoilOX

VIENNOT - PHILA

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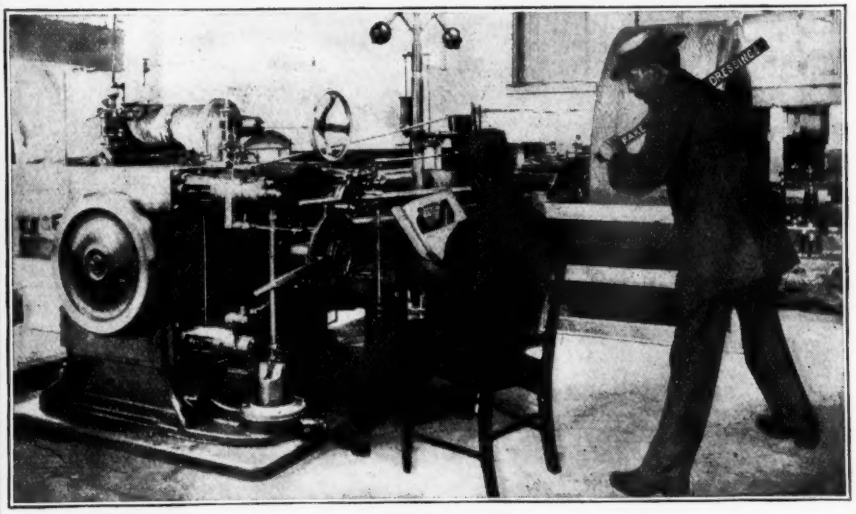

DON'T let some slick tongued fellow make you pay for ruining your own belts. **You know** that resin does your belts no good; you know that tallow and lard are not worth much for belt dressings; don't buy them then just because they are put up in an attractive package and labelled "Belt Dressing."

Get acquainted with **OXoilOX,** pure Neatsfoot Oil refined and improved so that it preserves and strengthens belts.

OXoilOX doesn't make belts sticky. It isn't a dope—it's a belt food, that keeps belts **soft** and **tough** and **clean.** Belts treated with **OXoilOX** cling to pulleys so closely that air is absolutely excluded, and the vacuum thus formed prevents slipping, and enables belts to **run slack** at full load.

Our booklet tells how **OXoilOX** was discovered—you'll be interested; mailed free on request.

A FREE SAMPLE

F. S. WALTON CO., Philadelphia, Pa.

Gentlemen: Kindly send us, free of charge, a sample can of OXoilOX the Perfect Belt Dressing.

Name.....Address.....

Name of Firm.....Number of Belts.....Average Size.....

F. S. WALTON CO., Philadelphia, Pa.

Pressers and Refiners of all grades of Neatsfoot oil.

Robins Laminated Leather Belting

Is made continuous without laps, plies or cement. Guarantees an equal distribution of strength and an uninterrupted line of power transmission.

Write for circular No. 2.

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MANUFACTURERS OF
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New York Branch, 88 Warren Street.
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Sales Agencies in all principal cities.
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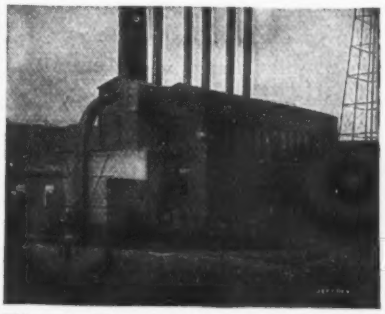
A MODEL POWER HOUSE EQUIPMENT
Employing Jeffrey Machinery



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Hoppers with Pivoted Bucket Conveyer for handling coal and ashes.

Elevating, Crushing, Screening, Conveying. Catalogues free.

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SHULTZ AQUA BELTING

is the only absolutely water-proof, steam-proof and acid-fume-proof belt. It is made from heavy selected hides, tanned by our secret process This tanning makes leather impervious to water, steam, oil, acid-fumes and unaffected by extreme changes in temperature and humidity.

Where the belts are exposed to water or excessive dampness Aqua will give better service than any other belting It will outwear any canvas, rubber or oak-tanned belt.

We send belts on 60 days' free trial.

Shultz Belting Company
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(Makers of "Sable" Rawhide and "Aqua" Belting, also Belt Dressing Cement and Lacings.)

REAGAN GRATES

The grate which carries with it a GUARANTEE to evaporate 25% more water than any other grate or stoker in the market under similar conditions or no money.

Adopted by the Boston and Northern Street Railway Co., and the Boston Elevated Railway Co., Boston, Mass.

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(TRADE MARK)
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BUILT ON THE TURBINE PRINCIPLE
SMALLEST BUT MOST POWERFUL
LIGHTEST BUT MOST EFFICIENT

FOR VENTILATING, HEATING, DRYING, COOLING, FORCED AND INDUCED DRAFT. BELT, MOTOR OR ENGINE DRIVEN. FITTED TO STEAM TURBINES.

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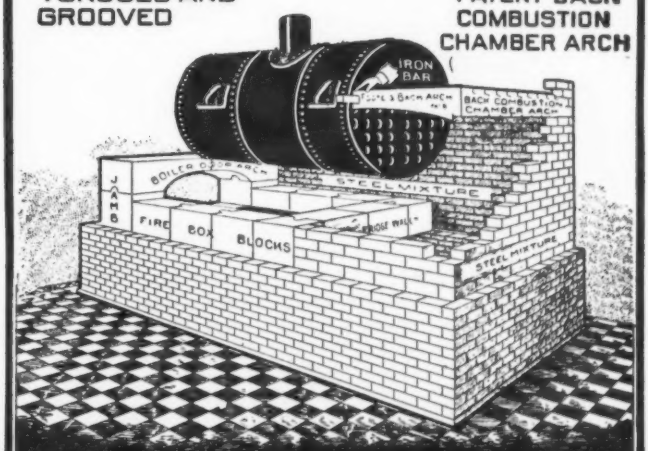
BOILER DOOR ARCHES AND FIRE BOX BLOCKS
TONGUED AND GROOVED
PATENT BACK COMBUSTION CHAMBER ARCH



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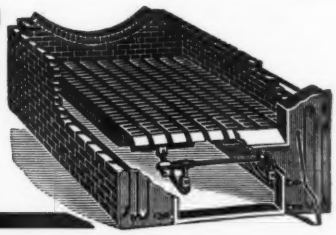
McLEOD & HENRY CO.
TROY, N.Y., U.S.A.
BRANCH OFFICE, 1402 BROADWAY, NEW YORK CITY.

SALAMANDER GRATE BAR COMPANY,

Makers of grates that save money by burning fuel completely.
We show the original Aetna grate which has 60% air space.
Write for full details.

126 Liberty Street, New York.



From The Coal Cellar To The Sky Above The Plant
WILKINSON'S AUTOMATIC STOKER AND SMOKE PREVENTER
makes its good influence felt and especially in the pocket that pays the coal bills.
THE WILKINSON MFG. CO., Bridgeport, Montgomery Co., Pa.

GREEN TRAVELING CHAIN GRATES
AUTOMATIC SELF CLEANING SMOKELESS
GREEN ENGINEERING CO.
COMMERCIAL NATIONAL BANK BLDG., CHICAGO.
GENERAL FOUNDY WORK A SPECIALTY

MARTIN GRATES
Martin Anti-Friction Rocking Grates will burn slack coal and get the same steam results as ordinary grates do with best lump coal. Catalog tells why.
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ANY TYPE OF BOILER
The Murphy Automatic Smokeless Furnace
burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.
MURPHY IRON WORKS, 5 Walker St., DETROIT, MICH.
UNITS OF ANY SIZE

Get Acquainted With the Monarch Boiler Arch
then you will have no more trouble with broken down arches and displaced brickwork.
Mayville Specialty Mfg. Company,
General Founders and Machinists,
Mayville, Wis.

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FIRE ARCHES
Any Rise, Any Span,
Air Baffle Mixing System
produces
RESULTS
C-O-TWO FURNACE COMPANY, Syracuse, N. Y.

PREVENT SMOKE
Write to us for descriptive matter relating to a device that is mechanically correct, simple in construction, absolutely automatic, and its effectiveness in preventing smoke from Bituminous coal under any and all conditions has been fully demonstrated.
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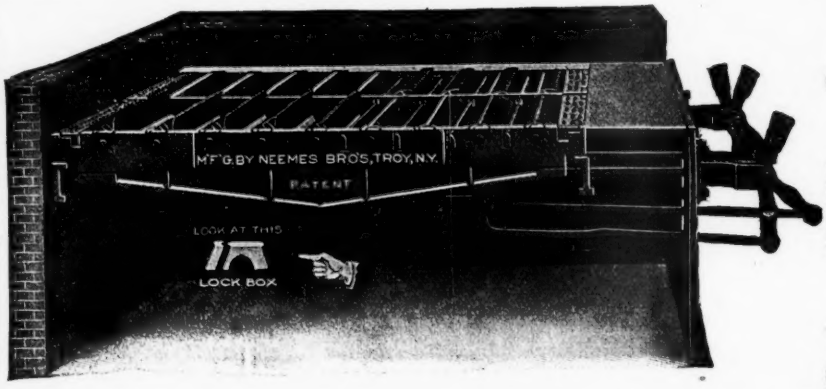
WIEDERHOLDT CONSTRUCTION CO.
American Trust Bldg., Chicago, Ill.

Over 7500 Hammel Oil Burners
In use under Stationary Boilers, Locomotives, Kilns, Etc.
Write for Circular of Hammel Patent Furnace for Water-Tube Boilers
HAMMEL OIL BURNER CO.
609 North Main Street, LOS ANGELES, CAL.



NEEMES BROS.
IMPROVED
Clinker Cutting, Shaking and Dumping Grate
unlike all other grates will cut from both sides of the shaker alike. Makes more steam with cheaper fuel and less of it. A slight agitation shakes out the ashes or a full opening dumps everything into the ashpit. *Write.*
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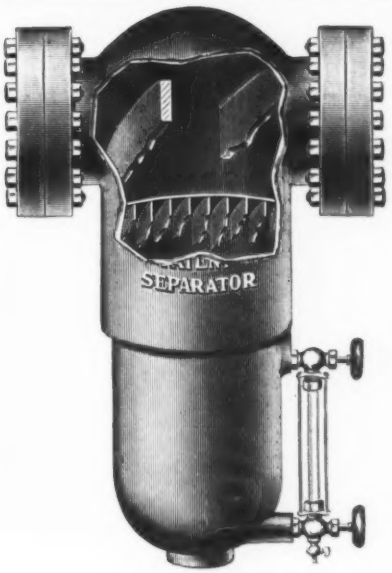
41-49 Adams St., TROY, NEW YORK
C. W. VAN BLARCOM, Room 533, Terminal Bldg., 30 Church St., Agent for New York City and vicinity. BABCOCK & WILCOX, Ltd., Montreal, Canada, Sole makers for Canada. BURKE ENGINEERING CO., 311 Industrial Bldg., Providence, R. I., Sole Agents for the New England States.

Vertical Type

Liberty-Greenaway Separators



Horizontal Type

Results Guaranteed!

...For...

Steam — Air — Oil — Ammonia

The exceptional high efficiency attained by the **Liberty-Greenaway Separators**, is due to the fact that they are designed in such a way as to utilize gravity to remove the entrainment.

There are no corrugated surfaces, perforated baffles, or centrifugal actions involved in their construction and operation.

They separate and remove the condensation or entrained water from live steam, and the oil and water from the exhaust, under either pressure or vacuum.

They will also remove all oil or condensation from **ammonia** or other gases.

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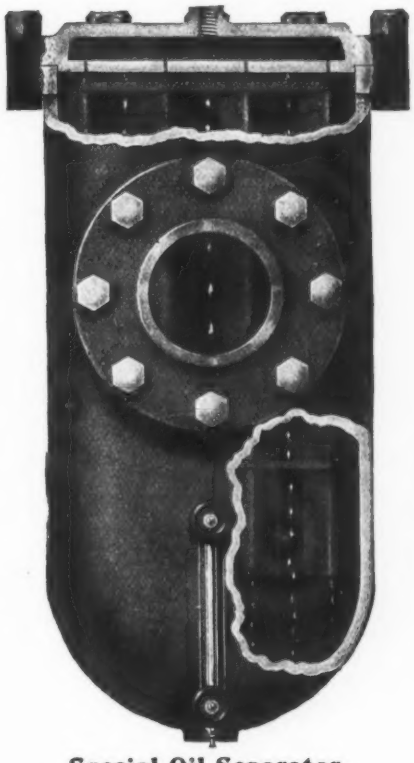
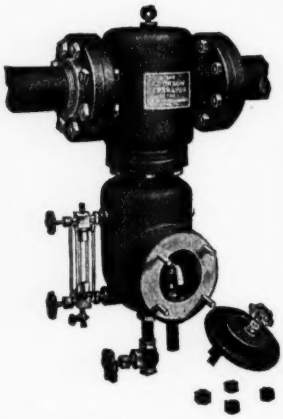


Special Oil Separator

LIBERTY MANUFACTURING CO.,

6509 SUSQUEHANNA ST., PITTSBURG, PA.

Keep the Water Out of Your Engine!



IT'S far better to prevent water from entering the cylinder of your engine, than to let it blow the cylinder head out. Water is also detrimental to the efficiency of an engine because it interferes with cylinder lubrication and is a source of many repair bills due to its cutting effect on the valves and cylinders.

The Cookson Automatic Separator

should be installed near the throttle of your engine as it will eliminate all of these troubles and greatly increase engine efficiency—by furnishing a constant supply of *dry* steam containing less than 1% of moisture. The economy and safety effected by its use will more than pay for the installation in a few months.

Let us mail you the Catalog, it tells all about it.

THE D. T. WILLIAMS VALVE CO.

904-910 Broadway, - CINCINNATI, OHIO

9

Forcing The Boilers

Won't Increase the Power of Your Engine

if wet steam goes into the cylinder. It must reach the engine

ABSOLUTELY DRY

in order to make the forced firing profitable. And in order to get dry steam you must have a

STRATTON SEPARATOR.

It is the only apparatus that is *absolutely infallible* under these conditions.

CATALOG WILL TELL WHY.

GOUBERT MANUFACTURING CO.,

No. 90 West Street. New York City, N. Y.

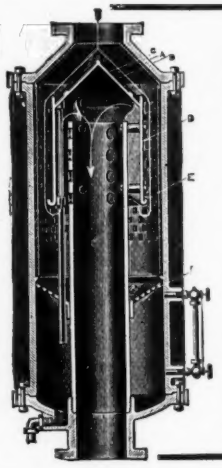
It Will Not Cost One Cent

to install and operate Baum Separators because if they are not satisfactory we will return your money and if they are satisfactory they will return it.

Send for new Catalogue and prices.

HERSHEY
MACHINE AND FOUNDRY CO.,
Manheim, Pa., U. S. A.

W. G. Ruggles Co., 54 High St., Boston, Mass.
R. D. Bliss, 40 Dearborn St., Chicago, Ill.

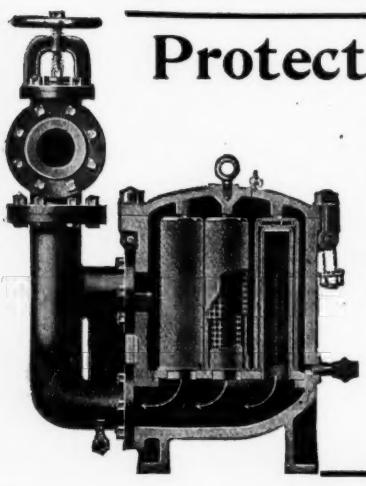


SWEETS

Steam Separators deliver 99.8 dry steam and oil separators remove 99% of oil from exhaust steam. They *do* it that's all. All styles.

DIRECT SEPARATOR COMPANY,

712 S. Geddes St., Syracuse, N. Y.



Protect Your Boilers and Your Profits

by keeping out oil and other floating feed water impurities. You can prevent the leaks, blistered tubes, bagged sheets and the waste of fuel caused by their impurities, by putting a

Blackburn-Smith Feed Water Filter and Grease Extractor

into the feed line. The filter will soon pay for itself in coal saved and reduced shut-downs and you won't need the boilermaker so often. Write for booklet "Feed Water Filtration."

106 Liberty St., **JAMES BEGGS & CO.,** 24 NEW YORK.

HOPPES

STEAM SEPARATORS

HAVE A PRINCIPLE OF THEIR OWN.

They contain no baffle plates or tortuous passages to wiredraw the steam or atomize the water of entrainment, but troughs partly filled with water intercept the entrainment and same is carried to the bottom of separator by drain pipe as shown in cuts.

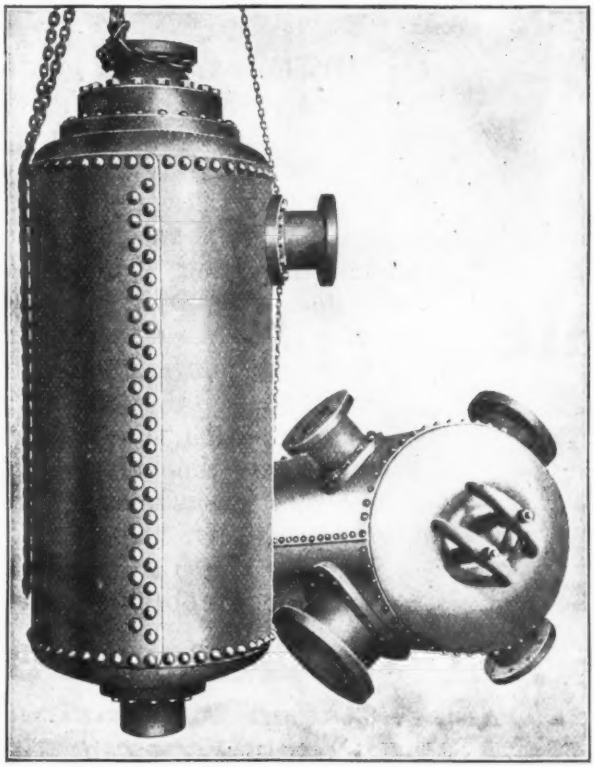
The bodies of Hoppes Separators are very large and afford a large storage of steam near the cylinder of engine, increasing its efficiency and protecting it from flushes of water from the boilers which so frequently wreck engines.

Standard Cast Iron Type are cast in one piece, sizes 1″ to 9″ inclusive, horizontal and vertical.

Standard Steel Shell Receiver Type, sizes 6″ to 20″ inclusive, vertical, horizontal and angle designs.

SPECIAL RECEIVER SEPARATORS.

Built in all sizes and designs and for any steam pressure, with the number and location of openings to suit conditions, each machine embodying the *Hoppes principle* of separation.



Send us specifications covering your requirements and we will submit prices and blueprints of separators to meet them. Every Hoppes separator is *guaranteed* to deliver 99% or better dry steam.

Live Steam Feed-Water Purifiers.
Exhaust Steam Feed-Water Heaters.

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Oil Eliminators.
Cast Iron Exhaust Heads.

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HOPPES MFG. CO., 19 Larch St., SPRINGFIELD, O.

The

"SWARTWOUT"

Cast Iron

EXHAUST HEAD

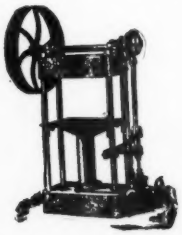
Built for a life-time of service.

You can't break it and it won't wear out.

THE OHIO BLOWER CO.

CLEVELAND, OHIO

Also manufacturers of "Swartwout" Gravity-Closing Ventilators. 1-61



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WE have compiled in catalogue No. 70 a few of the more common type of Hydraulic Forcing Presses used in shop purposes. This catalogue illustrates over 100 types of forcing Presses in tonnages from 2 ton to 1000 ton. Every press thoroughly guaranteed.

Send for catalogue.

WATSON-STILLMAN CO.,

50 CHURCH STREET,

NEW YORK CITY

Carey's 85 per cent Carbonate Magnesia Coverings

THE largest contract ever awarded for steam pipe and boiler coverings specified Carey's. This was the result of an exhaustive test conducted by the Manhattan Railway Company of New York, which proved Carey's Coverings to be more efficient and far superior in every way to any other of the numerous makes. No other coverings proved to be as light, clean and substantial.

Carey's Coverings are absolutely fire-proof, and being thorough non-conductors of heat they confine the heat to the pipes, effectually preventing its loss through radiation, thus saving in fuel an amount sufficient to *more* than offset the cost of their application.

The most prominent steam users everywhere use Carey's Covering. Do you want to know why?

Send for Carey's Magnesia Catalogue. It gives information not obtainable elsewhere.

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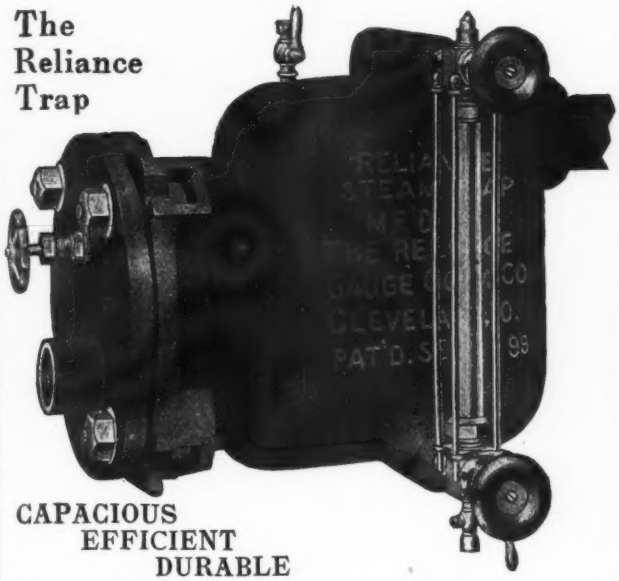
Exceedingly Simple

The Reliance Trap



CAPACIOUS
EFFICIENT
DURABLE

Good, strong, heavy castings; put together with mechanical accuracy that insures long life and satisfactory service. *Write.*

THE RELIANCE GAUGE COLUMN COMPANY

75 E. Prospect St., CLEVELAND, O., U.S.A.

Our Steam Traps

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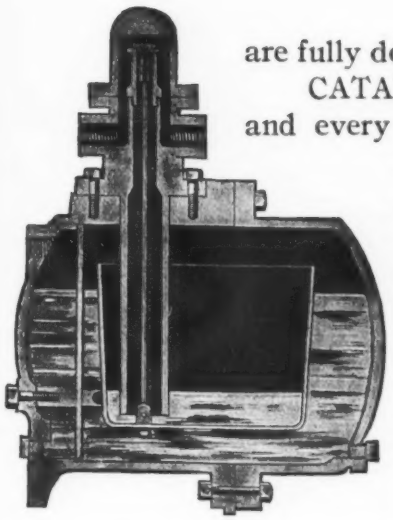

are fully described in our CATALOG "A" and every word said is backed by our guarantee.

If we don't make good we will return your money.

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Low Water Alarms,
Safety Water Columns,
Damper Regulators,
Low Pressure Boiler Feeders,
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KITTS SPECIALTIES

Pump Governors,
Reducing Valves,
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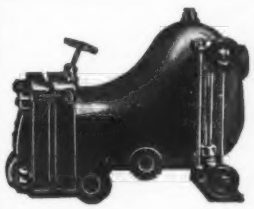

McDANIEL STEAM TRAPS

are especially adapted for draining steam separators and high pressure mains. Also good for steam heating. All working parts are attached to the bonnet, and are removable with it. Valve outlets are large, to give rapid discharges of condensation.

Watson Steam Pump Governor

should be used on all steam pumps where a fixed discharge pressure is desired.

The construction permits of easy access to the stuffing box for removing packing, and the spring can be adjusted or entirely removed without interfering with any other part of the valve. Any practical man will readily see its advantages.

All our goods are made in our own factory and tested before shipping. We guarantee them to give perfect satisfaction. Established 1878.

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Watson & McDaniel Co.,

148 North 7th Street, Philadelphia, Pa.

A 3" Water Seal

Prevents any loss of steam while permitting the escape of all condensation water.

¶ Every working part is easily withdrawn by simply removing the Head.

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THE V. D. ANDERSON CO.
1935 West 96th Street, CLEVELAND, OHIO.

FOR PURPOSES OF COMPARISON

our steam meter furnishes records which enable you to know how well your employees are attending to their duties.

It may also be used to measure water, air and other gases.

WRITE TO-DAY.

G. C. ST. JOHN,
140 Cedar Street,
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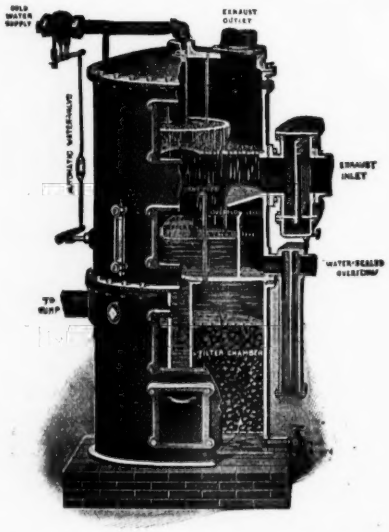
The St. John Indicating and Recording Steam Meter

THE WHITLOCK OPEN EXHAUST Feed Water Heater and Purifier



Perfect Oil Separation. Easily Cleaned. The Highest Possible Temperature in the Feed Water.

Manufactured by

THE WHITLOCK COIL PIPE COMPANY
HARTFORD, CONN.
New York Office—Singer Building, 85 Liberty Street.

WHAT IS IT?

This is the famous **GEIPEL STEAM TRAP,** made in seven sizes and for all pressures. *Circulars on request.*

JOHN PLATT & COMPANY, 97 Cedar Street, New York.

The Most Efficient And Least Troublesome

of all devices for draining condensation from steam systems is the

Morehead Steam Trap

Operating by gravity and without valves, floats, buckets or inside mechanism of any kind there is nothing to stick or get out of order.

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MOREHEAD MANUFACTURING CO.,
1051 Grand River Ave., Detroit, Mich.

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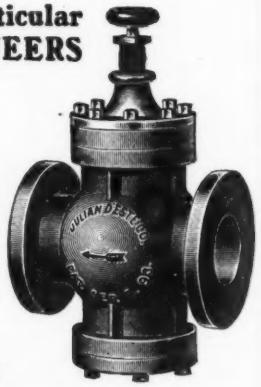
Return Steam Trap.

CURTIS SPECIALTIES For particular ENGINEERS

Improved Pressure Regulator
Improved Pump Regulator
Water Pressure Regulator
Expansion Trap
Balanced Steam Trap
Return Steam Trap
Relief Valve for Steam and Water
Separator
Cellar Drainer
Temperature Regulator
Tank Governor and Pump
Damper Regulator
U. S. Ball Cock



JULIAN D'ESTE CO., 24 Canal Street, BOSTON, MASS.

Heated Inside and Out

there is no chance for loss of heat by radiation when you use

The Baragwanath Steam Jacket Heater

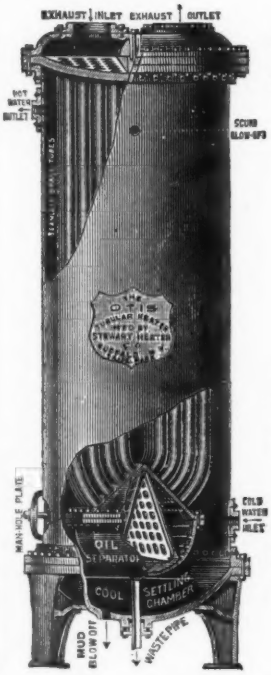
it is consequently easy to secure the real value of your exhaust steam, have your feed-water hotter and increase your boiler capacity if you use this device.

WRITE.

Wm. Baragwanath & Son,
54 West Division Street,
CHICAGO.

Thos. B. Whitted, Piedmont Bldg., Charlotte, N. C., Southeastern Manager.

Not a Penny of Cost



unless after a trial you are satisfied that

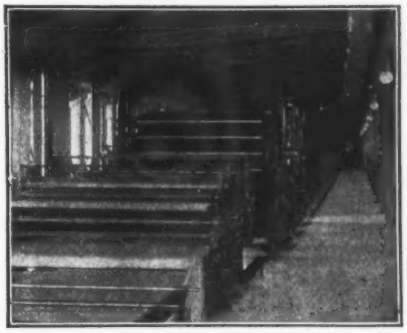
The Otis Tubular Feed Water Heater, Oil Separator and Purifier

makes good all our twelve comprehensive guarantees.

Used with our feed pump this heater saves from 15 to 25% over an injector.

Circular ?

THE STEWART HEATER CO.
45 E. DELAVAN AVE.,
BUFFALO, NEW YORK, U. S. A.



How About The Heating?

The proper design of a heating and ventilating system requires a high grade of engineering skill and experience. Plans must be adapted to utilize as far as possible the natural movement of air due to gravity, since nearly one-third of the heat imparted to air at constant pressure is not effective in raising the temperature, but is expended in doing the work of expansion, which can and should be utilized to aid movement.

It is not usually feasible to adapt the plan of a building entirely to the system of heating and ventilating, and at the same time it is often difficult to install a heating and ventilating system if no consideration has been given to it in the planning of the building.

For this reason, the building and the ventilating system should be developed concurrently, so that the total cost may be kept down while the efficiency of the heating and ventilating arrangement is improved. We have installed some of the largest heating and ventilating plants in public buildings and factories in this country.

We show above the machine room of a paper board mill completely equipped with our fans, heaters and engines. Not only do we supply special engineering, but apparatus is specially designed to meet special requirements. It is likewise made a little heavier and a little stronger and a little better in every respect than the general run of apparatus, a fact which we can demonstrate to you if you will give us the opportunity.

Ask for our special Booklet "109 P" on Heating and Ventilating.

The
Green Fuel Economizer Co.
MATTEAWAN, N. Y.

New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal.

Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines. 127

Harrisburg Feed Water Heaters

Of Pure Seamless Copper Coils. Guaranteed to be the most effective, most durable and cheapest heater manufactured.

Please write for Descriptive Catalog.

COPPER, IRON AND BRASS PIPE COILS AND BENDS OF ANY DESIRED SHAPE

Manufactured by

The Harrisburg Pipe & Pipe Bending Co.

950 HERR STREET, HARRISBURG, PA.

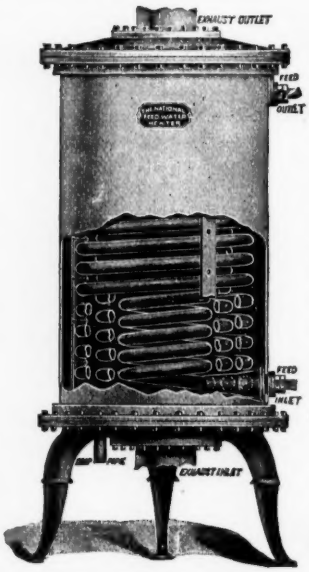
Manufacturers of HIGH GRADE

Wrought Iron

PIPE

BLACK AND GALVANIZED

Testimonials



By the Hundred

coming from us might not carry as much weight as if you wrote *direct* to some of the users and buyers of the National Feed Water Heater. Therefore we'll send you on request a list of users to whom you can write. We want to *prove* that the "National" is the simplest and best heater made

Shall we mail you the list ?

WRITE FOR CATALOG

The

National Pipe Bending Co.

175 Lloyd Street,

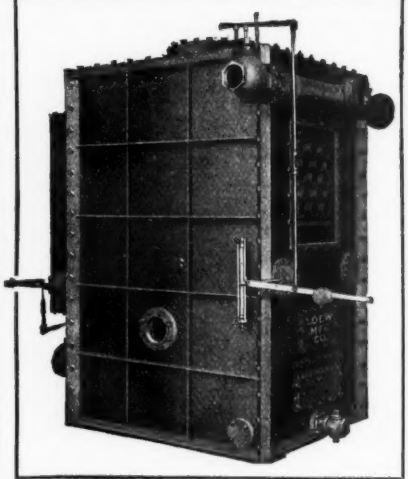
NEW HAVEN, CONNECTICUT.

120 Liberty St., New York. 54 High St., Boston, Mass.

The First Precaution

against boiler explosion is the installation of

Loew Feed Water Heaters



They keep your boilers free from repairs and all possibility of disaster.

Simple in construction and built to utilize the full efficiency of the exhaust steam.

Occupy minimum space and secure maximum heating capacity in shortest possible time.

No clogging of Filterbed.

Easy to get at and clean all parts of Loew Heaters.

Send for catalog.

The Loew Mfg. Co., Cleveland, O.

ALL SIZES TO 6,000 H. P.

You Can Turn The Riblet Inside Out

Simply remove the scum blow-off pipe, the feed inlet and outlet, then with a tackle lift out the tubes and inner chamber without disturbing the heavy pipes.

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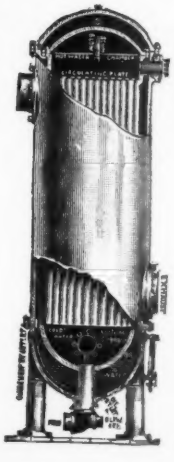
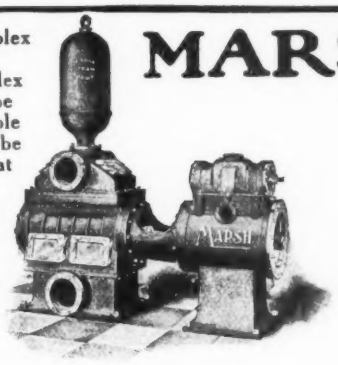
Erie Manufacturing and Supply Co.

1203 Peach Street, Erie, Penna.



Simplex Not Duplex To be Simple is to be Great

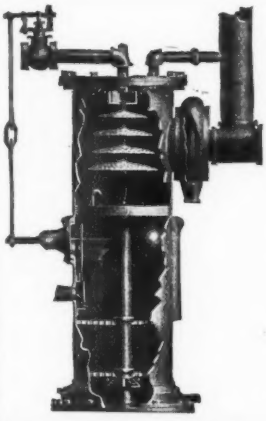
MARSH BOILER FEEDERS



are designed for handling hot as well as cold water. They are *at regular prices* fitted with bronze Piston Rods, bronze Water Cylinder Liners held in place by Studs, bronze Valve Seats, Stems, Nuts and glands. THE BEST OF MATERIAL AND THE BEST OF WORKMANSHIP ONLY GO INTO **MARSH PUMPS.**

Write for Catalog 17-G.

American Steam Pump Co., Battle Creek, Mich.



OUR TWINS

EITHER ONE WILL SAVE 15% of fuel and preserve the boiler.

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The Sims Co.,
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Branch Office:
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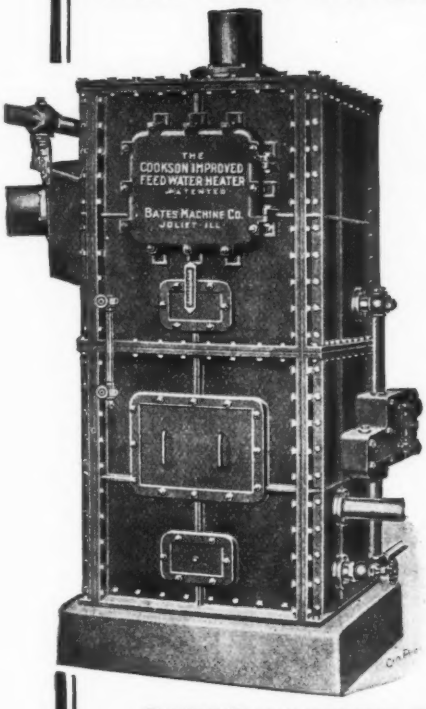
BURNHAM
STEAM PUMPS
ALSO
POWER PUMPS—AIR COMPRESSORS—CONDENSERS
UNION STEAM PUMP CO.,
BATTLE CREEK, MICHIGAN.

300° Is Too Hot For Scale

and it's just this excess over the ordinary heater temperature that makes the Eclipse a protection against scale. Write.

The Eclipse Feed Water Heater & Purifier Company,
Oshkosh, Wisconsin.

COOKSON STANDARD ALL CAST IRON FEED WATER HEATERS



Highest Temperature and Positive Purification of feed water.

Perfect Separation and Removal of Oil.

Automatic Control of Cold Water Supply.

Dry Steam for Heating Purposes.

Finest Grade Special Fittings.

Lime Catching Pans. Especially Adapted for use with Heating Systems, Dryers, Etc.

Write for our new Heater Catalog.

BATES MACHINE COMPANY
Sole Manufacturers Joliet, Illinois

On Land And Sea The "Reilly" Wins

It's the simplest, most durable and most highly efficient feed water heater ever devised. It is *compact, light* and totally free from scale. The "Reilly *Multicoil*" is worth looking into.

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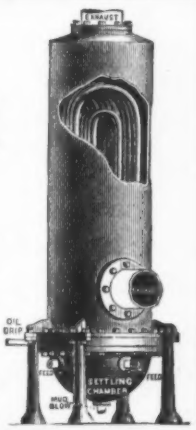
The Bottom May Be Dropped
And The Tubes Removed From A

Patterson-Berryman Feed Water Heater And Purifier

without disconnecting the large pipes. Our catalog gives full details and our 60-day trial offer. Write for it.



Frank L. Patterson & Co.
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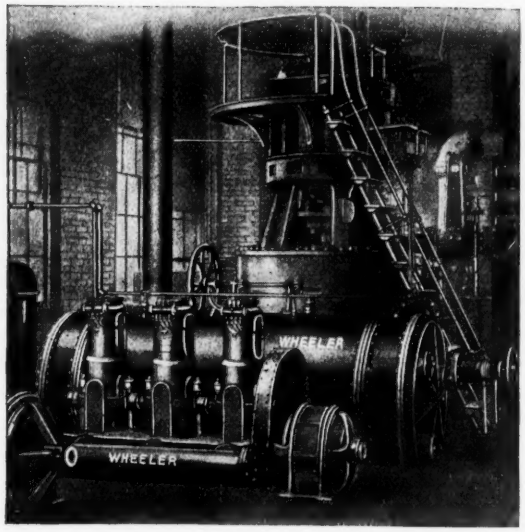

HOW MUCH IS HIGH VACUUM WORTH?

A vacuum of 28½ inches is maintained steadily under full load conditions by a large number of Wheeler-Edwards pumps now in use with Surface and Jet Condensers.

How much more is this worth to the owners than the 22 inches or 25 inches that they would get with the ordinary air pumps or than the 26 or 27 inches obtained by dry-vacuum pumps, hot well pumps and air coolers?

The fact that steam turbines make such excellent use of high vacuum has led some to suppose that it was not worth while to strive for high vacuum with reciprocating engines, but a contributor to a recent issue of POWER shows that this is not the case. He found that with his 200 H.P. compound engine running on a vacuum of 22½ inches, the surface condenser discharged 50 pounds of water per minute; with a vacuum of 27 inches the flow was reduced to 44 pounds while with a vacuum of 28½ inches only 40 pounds of steam per minute were required.

Figuring this up on the basis of 10 hours per day and 365 days per year, and assuming 8 pounds of steam evaporated per pound of coal, you will find that is between 22½ inches and 28½ inches of vacuum there as a difference of about 137 tons of coal per year. Enough, we should say, to repay handsomely all interest and other charges on a Wheeler-Edwards pump, so that the owners of a plant where only a 22 inch or 24 inch vacuum can be obtained with the present pumps can well afford to throw the latter away and buy a Wheeler-Edwards pump.

Send for our special treatise "103 P".

WHEELER
CONDENSER & ENGINEERING CO.
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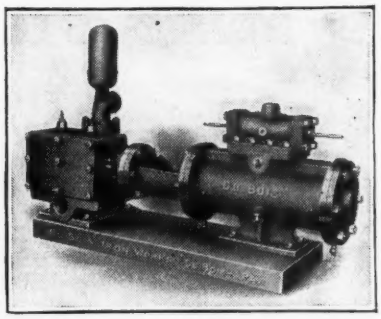
New York, Cincinnati, Chicago, Denver, Boston, Pittsburg, St. Louis, San Francisco, Atlanta, Houston, St. Paul.

(Builders of Wheeler Surface, Jet and Barometric Condensers, Wheeler-Volz Combined Surface Condensers and Feed Water Heater, Wheeler Feed Water Heaters, Barnard-Wheeler Cooling Towers, Wheeler-Edwards Air Pumps, Wheeler Centrifugal Pumps, Wheeler Rotative Dry Vacuum Pumps and Wheeler Multiple Effect and Evaporating Machinery). 18

UNEQUALED



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DuBois Pumps

are entirely automatic in operation and are guaranteed to give perfect satisfaction.

We ship pumps on 30 days' trial and if unsatisfactory same may be returned at our expense. Purchaser takes no risks.

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Established 1877
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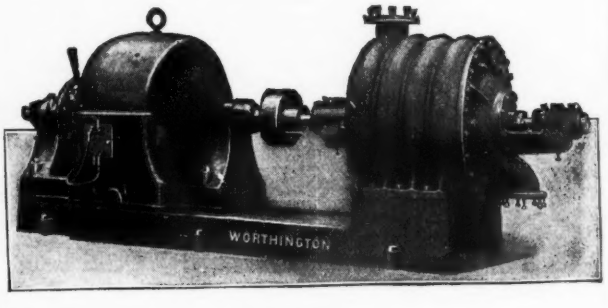
TURBINE PUMPS



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Require very little attention.
Built to suit your conditions.

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85 LIBERTY STREET, NEW YORK

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STEAM SUPERHEATERS—MECHANICAL STOKERS

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mean lower fuel bills and freedom from expensive boiler troubles. They supply absolutely dry steam, superheated to over 80 degrees. Made in all sizes from 50 to 1,000 H. P. They're the boilers that will save you most. CATALOG ?

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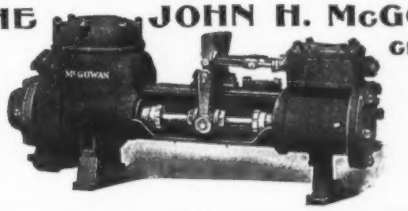
Simple Plunger Pump

Simple and Duplex Boiler Feeders. Jet and Surface Condensers. Power and Electric Pumps.

THE JOHN H. McGOWAN CO.

Cincinnati, Ohio



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Single Duplex and Fly-Wheel Types
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Condensers, Cooling Towers, Vacuum Pumps, Heaters

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PISTON HYDRAULIC *DEEP WELL PLUNGER* *VERTICAL POWER*

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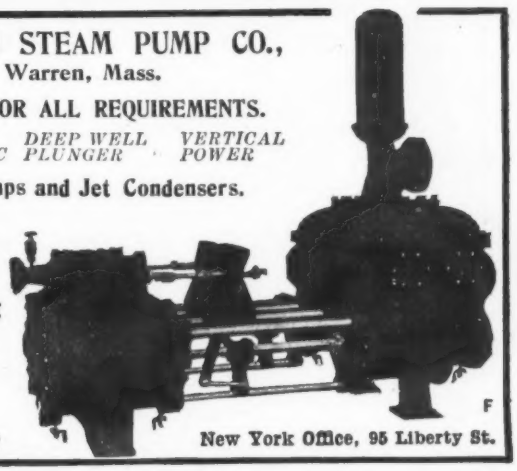

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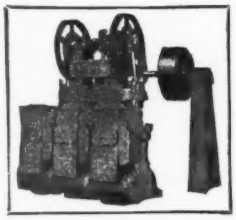

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For any service. For operation by any power.

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Goulds Efficient Power Pumps

are growing in favor wherever they are installed. Let us send you Catalog of Pumps for every service.

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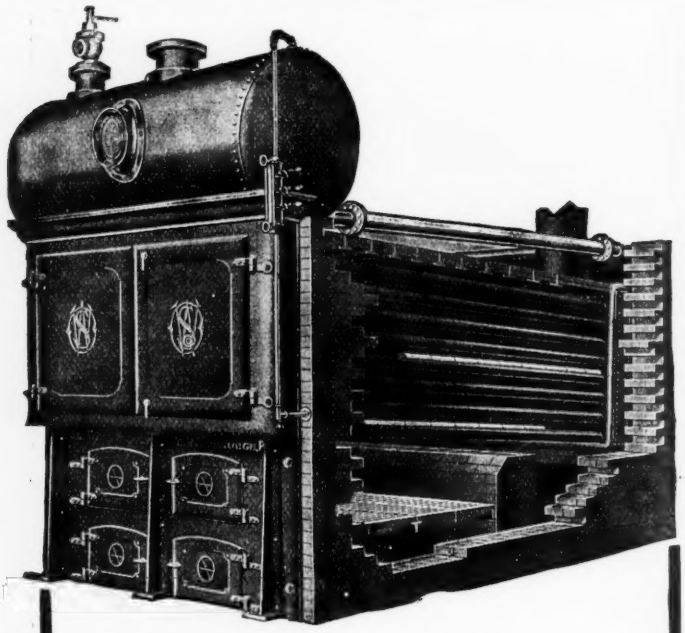

The Basis Of Economy

in any power plant is the boiler system. If you appreciate that fact you will do well to investigate

Our Safety Water Tube Boiler

Built for any pressure from 125 to 300 pounds. Meets all the high duty requirements of modern triple and quadruple expansion and compound engines. Perfect circulation, remarkable economy, and freedom to expand and contract, are features.

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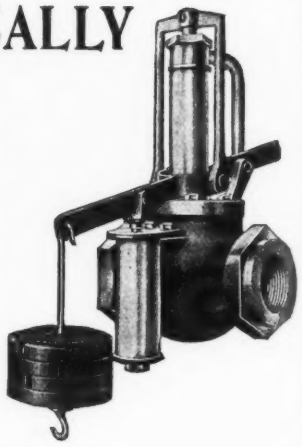
REDUCE THE STEAM AUTOMATICALLY



THE DAVIS PRESSURE REGULATOR operates on the principle of balancing the pressure by direct weight. This simple and effective arrangement insures a degree of sensitiveness that never fails. No troublesome packing, auxiliary valves, internal dash-pots or small ports to become clogged with scale.

If you want to reduce the steam from any initial pressure to any delivery pressure, and maintain it constantly, *you need the "Davis."* BOOKLET?

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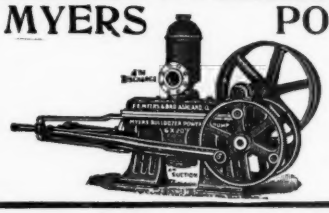

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Catalog sent on request.

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Get Additional Power From Your Boilers

and keep them in better condition by using Wing's Turbine Blowers for mechanical draft. *Write.*

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All Flange Steel Construction

Send for { Boiler Logic and Superheater Logic

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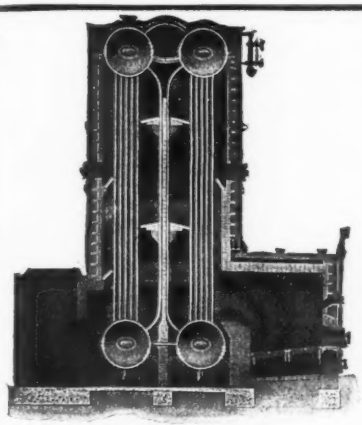

TYPE B

THE RUST
WATER TUBE
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SAFE, SIMPLE, DURABLE,
ECONOMICAL, ACCESSIBLE

Write for Report of Tests by William Kent.

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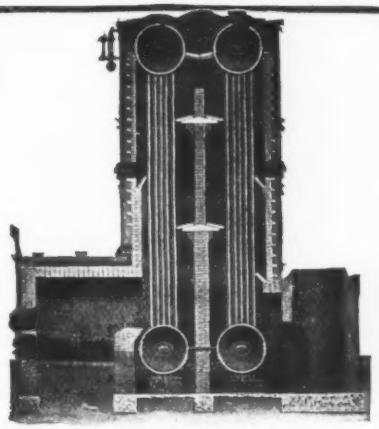
Branch Offices: New York, 50 Church Street; Birmingham, Alabama, First National Bank Building.



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WATER TUBE BOILERS—SUPERHEATERS.
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Foster Superheaters

Insure economical steam consumption on light loads.

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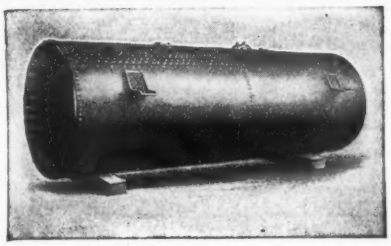

WICKES Horizontal Tubular Steam Boilers
HIGHEST GRADE

THE WICKES BOILER CO.
Also Manufacturers of the Wickes Vertical Water Tube Safety Steam Boilers
Main Office and Works, Saginaw, Mich.
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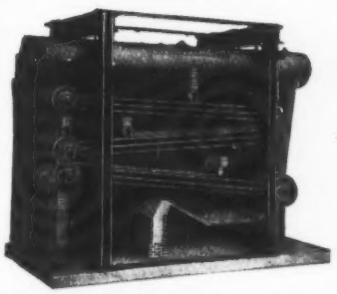
THREE TIMES

the water has to pass back and forth through the hot gases in the Vogt Water Tube Boiler. This not only gives greater heating capacity, but also prevents scale. The "Vogt" is made entirely of steel.



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HENRY VOGT MACHINE CO., Inc.,
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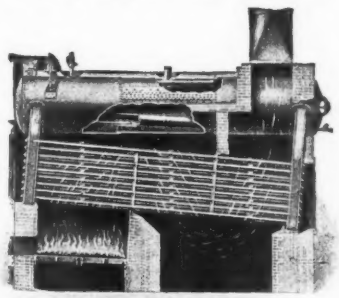
Water Tube Boilers



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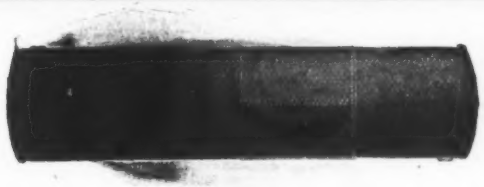

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Edge Moor Boilers
—WATER TUBE—
EDGE MOOR IRON CO., Edge Moor, Delaware

Large Units a Specialty.

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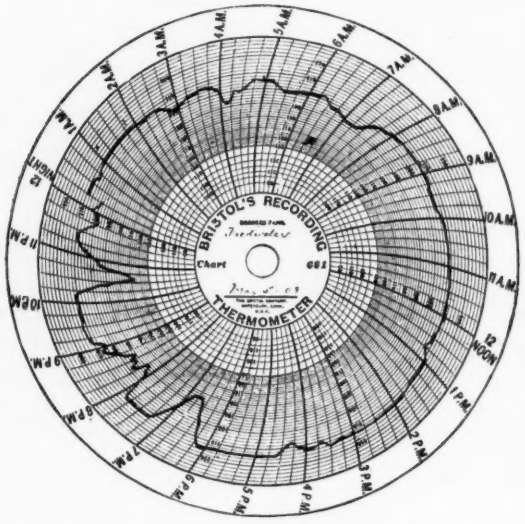

Before and After Using the Copes Boiler Feed Regulator

Note the marked difference in the fuel saved by the open feed water heater.

These charts were made by the recording therometer located in the boiler feed line and show accurately the fluctuations in feed water temperature on the respective days. It will be seen that after the Copes Regulator was installed the temperature held pretty closely between 210 and 212° F., while before the Copes Regulator was put in the temperature occasionally fell as low as 170° F. The periods of low temperature represent heat losses and therefore wasted coal, and taking a boiler plant of 20,000 H. P., say, it is not difficult to figure up approximately what this coal saving due to the Regulator amounts to.

The Copes Regulator pays for itself in addition to protecting the boilers from the effects of low water, and the engines, turbines and pumps from the effects of high water.

The Copes Regulator is boiler insurance. It is the only Regulator having no floats, springs or diaphragms and the few working parts are outside in plain sight. We guarantee it for FIVE YEARS. Ask for our Catalog P.

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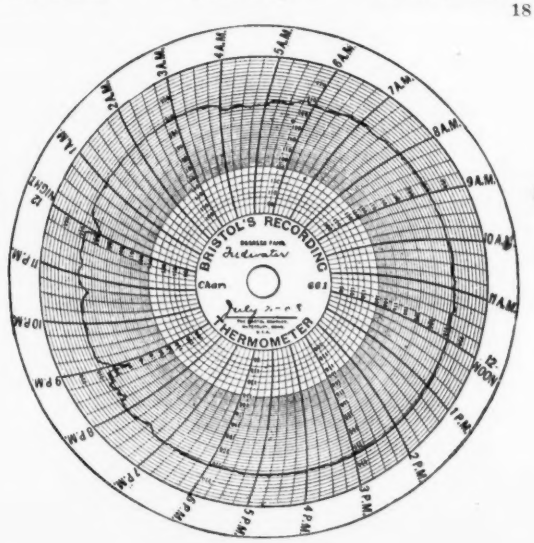
18



THE
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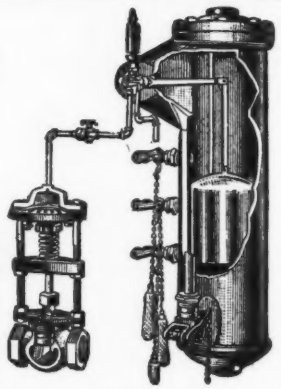
Safety
Automatic
Feed Water
REGULATOR



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We Were Pioneers

in the manufacture of steam pump governors, and no other manufacturer has ever overtaken us in the race for supremacy. Fisher Governors are still the best, most economical and least troublesome governors made.

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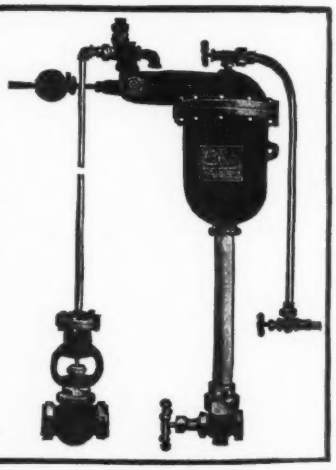
The Vigilant Feed Water Regulator

for Steam Boilers was the first in the field, and has the longest and best record of any of these devices. *Costs less to operate and maintain.* Constructed on a differem and better principle than any other. Investigate it and the FULTON PUMP GOVERNOR, and send for latest catalog with list of users. A guarantee from a responsible firm with every machine.



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IF THE BELT BREAKS

or slips off the pulley, the support of the fulcrum is forced back, allowing the fulcrum to drop, instantly closing the valve.
Ask for further particulars.

Catalog?

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Why Buy a STURTEVANT ELECTRIC FAN?

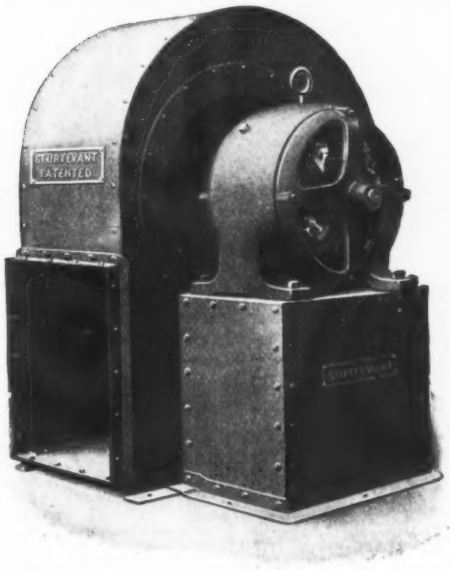
BECAUSE the Sturtevant Fan is the most Efficient Commercial Fan in the WORLD.

BECAUSE the Sturtevant Motor is designed especially for the fan—low heat rise, great overload capacity.

BECAUSE both fan and motor are selected to save power, both are just right in size and speed.

BECAUSE the B. F. Sturtevant Co. has had 50 years' fan experience.

Ask for Bulletin No. 158.



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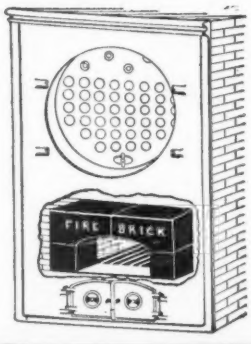
CROCKER-WHEELER COMPANY
Ampere, N. J.

Your Boiler Settings



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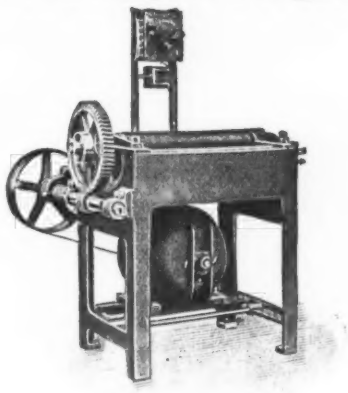

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TRIUMPH ELECTRIC CO.
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New York, 1 Madison Ave. Chicago, Great Northern Bldg.

Weiss Counter-Current Condenser.

We are sole licensees in the United States for the manufacture and sale of this Condenser, and will gladly send particulars to any one interested.

We guarantee any desired vacuum, using less cooling water and of higher temperature than other apparatus.

All contracts made upon positive statements as to relative volume of steam and water.

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20 x 42 Allis, Corliss	16 x 32 Buckeye, Automatic
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Also large assortment of Automatic and Throttling Engines of other sizes.

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84 x 18, 78 x 16, 72 x 18 High Pressure, 72 x 16, 66 x 16 and smaller sizes of Horizontal Tubular Boilers, also Vertical and Fire Box Boilers from 5 to 60 H. P.

Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc.

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York, Pennsylvania

We manufacture all machinery and parts needed to equip a complete Ice or Refrigerating plant—

Machines, Condensers, Tanks, Cans, Coolers, Piping, Boilers and Ammonia Fittings.

of all kinds. We employ over 1,250 men in the manufacture of Ice and Refrigerating Machinery exclusively. Catalogue sent upon request.

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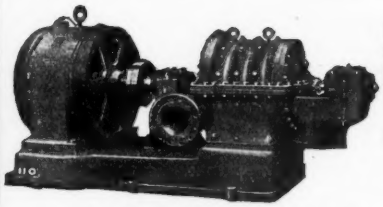

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Steam Turbine Motors
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Steam Turbine Centrifugal Pumps
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DE LAVAL STEAM TURBINE CO.,
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"True In The Long Run."

"YOUNGER TRIUMPH"

A little duplicate of the regular Triumph compressor. Built to make only from 2 to 3½ tons of ice, it performs its work as economically as our 50 ton compressor. The Younger Triumph is "True In The Long Run."

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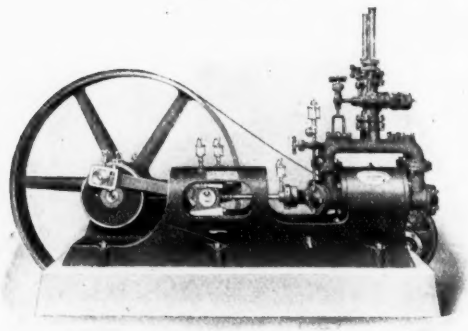

TRIUMPH ICE MACHINE CO.,
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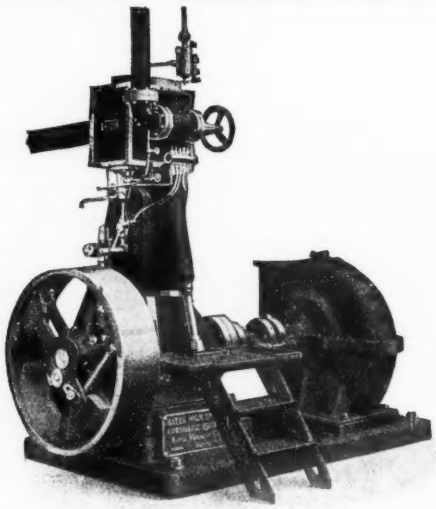

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WATER WORKS, IRRIGATION

and other places where it is desired to move a large volume of water at small expense.

CATALOG FOR THE ASKING.

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THE CHEAPEST POWER IN THE WORLD

GAS ENGINES, GAS PRODUCERS
COMPLETE PLANTS INSTALLED

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FOOS GAS AND GASOLINE ENGINES

HAVE WIPE SPARK IGNITER, positive acting and self cleaning.

VERTICAL VALVES, mechanically operated, admit fuel charge into cylinder at atmospheric pressure.

CENTER-LINE COUNTERBALANCING increases the efficiency and decreases the fuel bills.

ACCESSIBLE DESIGN makes it a simple matter to keep Foos Engines properly adjusted.

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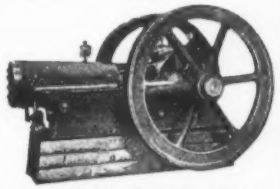
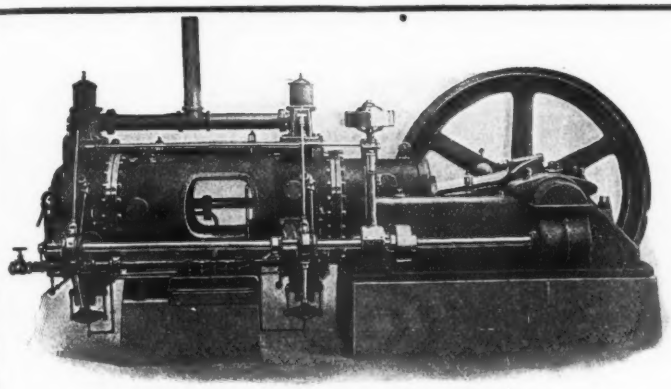


THE FOOS GAS ENGINE CO., SPRINGFIELD, OHIO.



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Types up to 700 H. P.

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Economy and Reliability Have Been Demonstrated by Actual Service

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That's what we'll do the instant you give us the word. If your Cylinder needs reboring, or any other engine troubles arise, there's no necessity of knocking down your engine. We are expert engine repairers and can rebore your cylinder right in position. You'll save money by sending for us.

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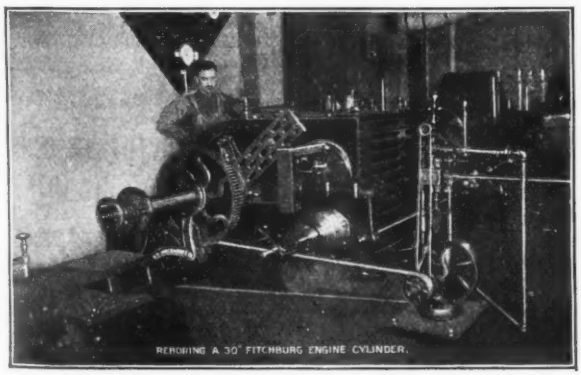
"Useful Hints P" sent to Engineers upon request.



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H. B. UNDERWOOD & CO.,
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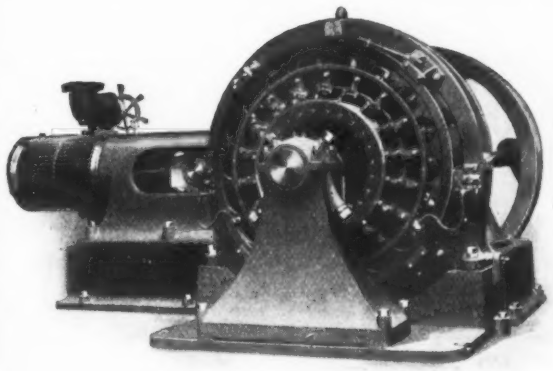

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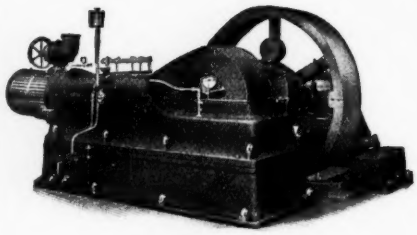

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CENTER CRANK
SIDE CRANK
SINGLE and FOUR VALVE

Skinner Engine Co.,
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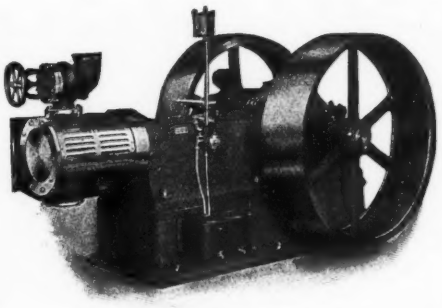

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Their valve gear gives better steam distribution than that of any other single valve engine.
Catalog shows indicator cards. Write for it.

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WHAT PART OF YOUR POWER DO YOU USE?

The plain, simple brute force which can be reckoned in horse power or the convenient, versatile (we may say "intelligent") power afforded by Northern Apparatus? ¶You need better power than ordinary methods afford. Northern Machines and methods are best. They assure maximum convenience in the arrangement of production machines, maximum economy in the application of labor and maximum profits. ¶An intelligent discussion of the use of Northern Machines in your work necessitates that we know what your work requires. Tell us and ask us incidentally for booklet 839.

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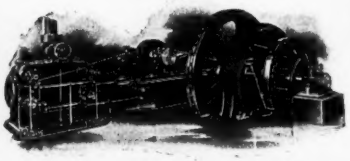

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For Reliability and Economy.
Built by
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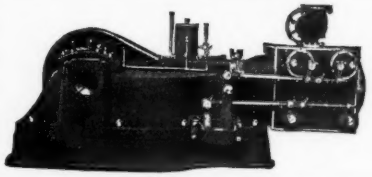

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We Manufacture
AN ECONOMICAL AND DURABLE ROTARY ENGINE
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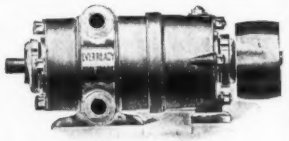

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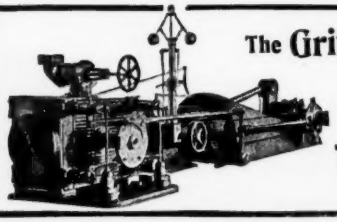

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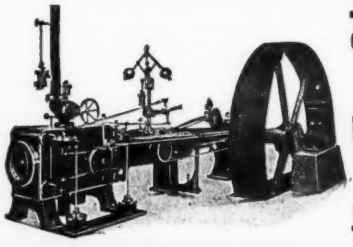
Manufacturers of
The Ohio Corliss Engine and Hoisting Engines



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ACCURATE REGULATION FOR ELECTRIC SERVICE—AUTOMATIC CUT-OFF AND RITES FLY-WHEEL GOVERNOR

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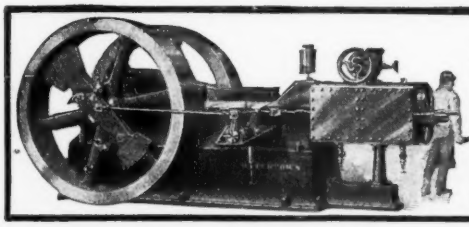

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for every power purpose. Ask for Catalog.
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Manufacturers

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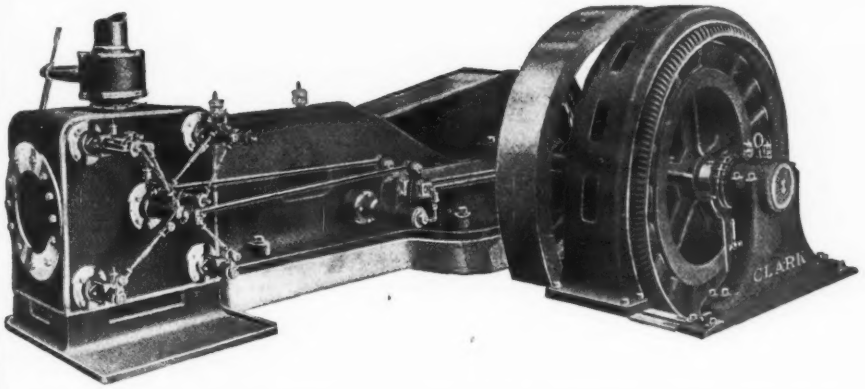

An Engine Without a Peer

Built simple, tandem and cross compound, and for speeds up to 200 R.P.M. Has ALL the advantages of the releasing gear Corliss, with none of its objectionable features or limitations.

The only Corliss engine ever designed having an unvarying valve travel, with perfect cut off at any point from zero to three quarters stroke. Engineers should investigate this engine. Catalogue free.

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BUILDERS OF HIGH CLASS

STEAM AND GAS ENGINES

HIGH IN DUTY, SUPERIOR IN REGULATION

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ABSOLUTELY RELIABLE

CORRESPOND WITH US BEFORE PURCHASING

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Fine Results From Cooper Corliss Engines

are being secured in all classes of service. We are Engine Builders and also do Complete Steam Plant Engineering.

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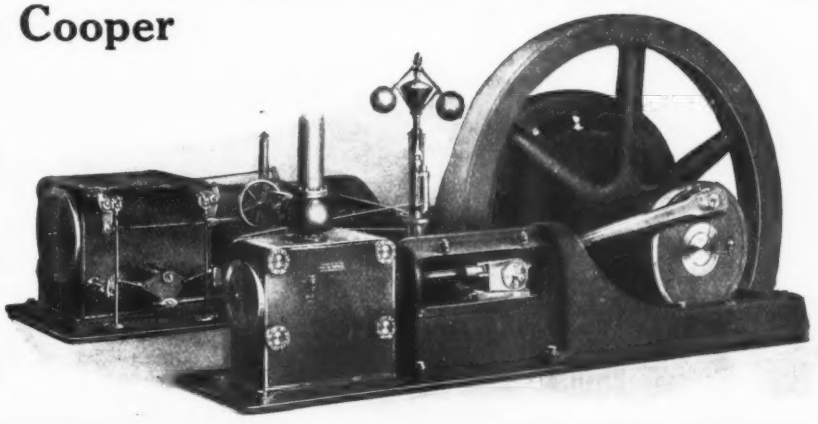
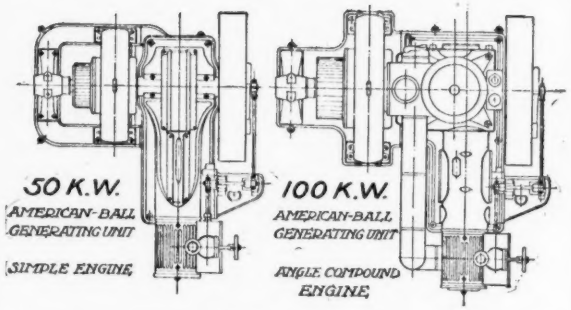


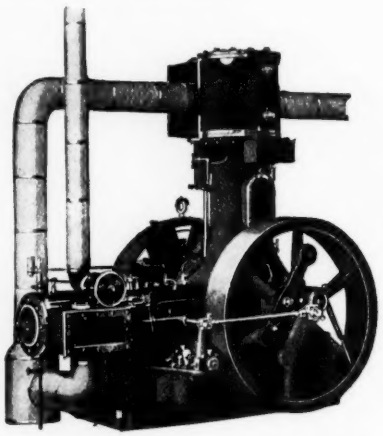
Twice the Power In the Same Space



These two generating units, shown on the same scale, merely indicate how much space can be saved by installing

THE AMERICAN-BALL ANGLE COMPOUND ENGINE

in preference to a simple engine. It will be noticed that a 100 K. W. Generator driven by our Angle Compound occupies practically no more space than a 50 K. W. Generator driven by a simple engine. This American-Ball Angle Compound Engine goes into much smaller space than a tandem or cross-compound.



So much for space saving. Steam saving is another feature in which these Angle-Compounds have proven their merits. Their steam economy is equal to or better than that of any other high speed single valve engine of equal power.
If you appreciate a carefully designed and built engine, one that is compact, closely governed, economical and at all times dependable, we are ready to meet your requirements.

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AMERICAN ENGINE COMPANY
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BOUND BROOK, NEW JERSEY No. 9

Curtis Turbine Generators also Appeal to Power Plant Owners

Because

the turbine may be installed on a small and inexpensive foundation without heavy or rigid support, as it runs without strain on foundations

and

operates satisfactorily in any place where noise and vibration cannot be tolerated and where clean operation and small oiling expense is appreciated—

because

the steam consumption guarantee is a straightforward statement of actual quantities measured with standard instruments and includes all losses in the turbine and generator,

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the turbine will retain its efficiency over a long term of years as there are no internal wearing parts.

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STEAM TURBINES

You will generally find

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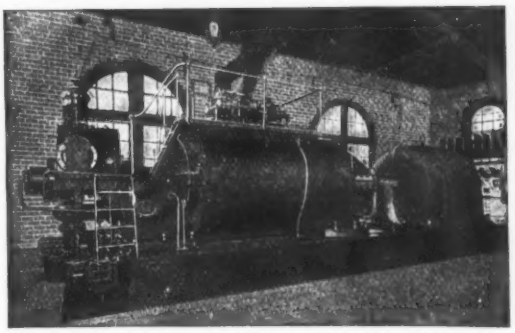

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Steam Engines,
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Chicago, 171 La Salle Street.
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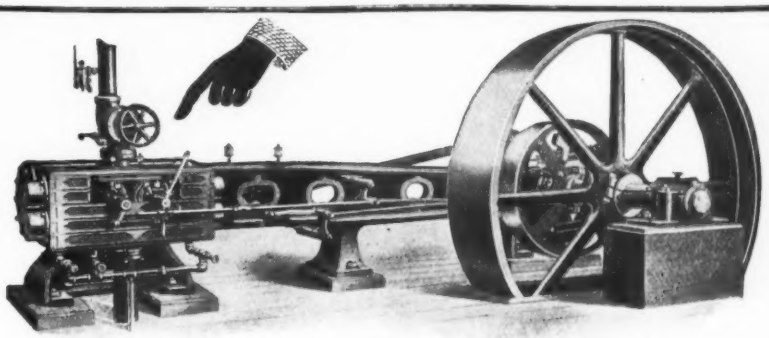
It requires less time and effort to keep a Fitchburg Engine

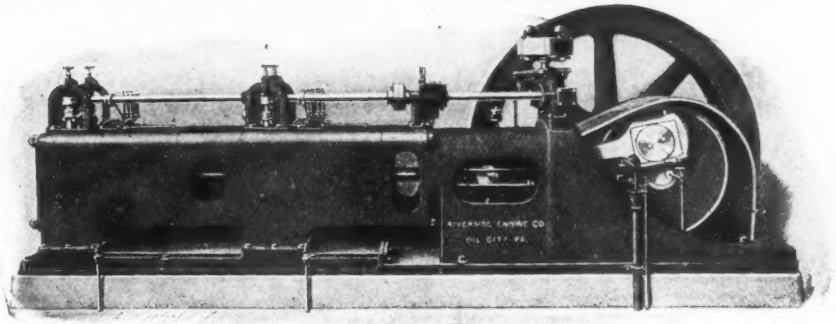
Steam Tight

for twenty years than any other engine for one year. Write for Fitchburg facts.



Fitchburg Steam Engine Co.,
FITCHBURG, MASS.

Geo. H. Connor, 509 Mutual Life Bldg., Philadelphia. E. H. Ludeman & Co., 165 Broadway, New York. H. J. Gebhardt, 1419 Fisher Bldg., Chicago. W. C. Teas, Chattanooga, Tennessee. Western Trading Co., San Francisco.



Riverside Heavy Duty Single Acting Tandem Gas Engine (Class C),

Not Made From Wash Drawings

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We also Build a Complete Line of Gas Driven Air and Gas Compressors

Riverside Engine Company, Oil City, Pa.

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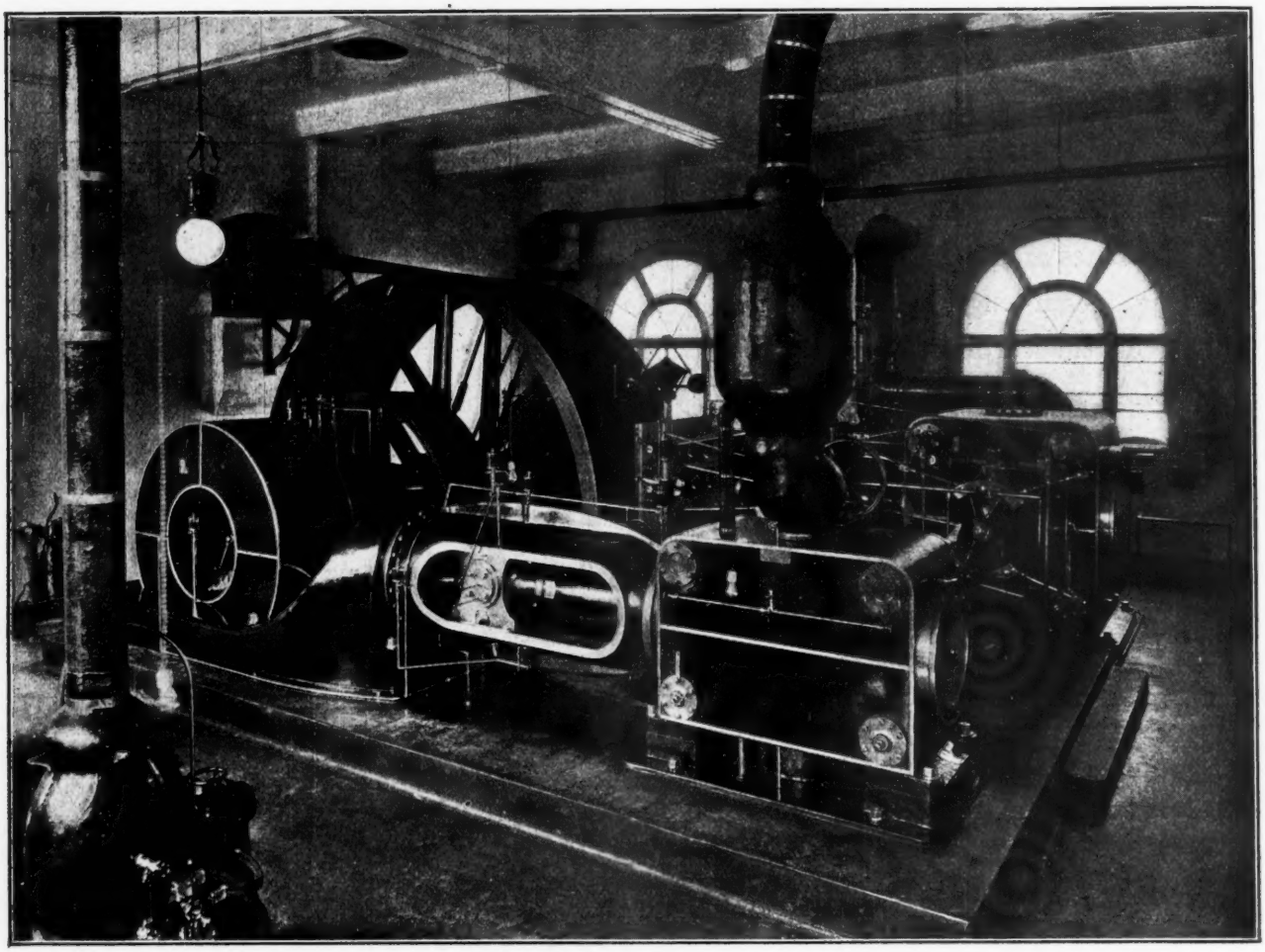
Twin City CORLISS ENGINE



Large Cross Compound Twin City Corliss Engine running one of the largest Flour Mills in Minneapolis. 18 ft. fly wheel grooved for 24 2-in. ropes.

All auxiliaries driven by belt from main engine giving greatest possible economy in steam consumption.

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Considering Only The Waste In Handling Oil, It Pays To Use KEYSTONE GREASE

The "overflow" that generally occurs when you fill your oil cups cannot happen when grease is used, and that continuous waste amounts to many gallons a year, in large plants. For that reason alone it pays to use our Lubricant—and besides

"Keystone" Lasts 50 Times As Long

This well-known Grease has revolutionized machine lubrication by its high efficiency and unparalleled economy.

Its consistency is such that it does not melt at 300° F., and it will work in coldest places as well as on the most heated parts of an engine. Every particle of "Keystone" is potentially valuable in lubrication and it is used up to the last bit. No sediment or gum is left behind to clog and stick in the bearings

In a word, Keystone Grease is the one perfect lubricant whose coefficient of friction is less than any oil or other grease known.

KEYSTONE TRADE MARK REGISTERED U.S. PAT. OFF.

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TWIST—sizes 1-8", 3-16" and 1-4", on 1 lb. spools, for small stems.

BRAIDED—(round and square) from 1-4" up, in 5 lb. boxes, for large stems.

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SPECIALISTS IN
Recording Instruments
FOR
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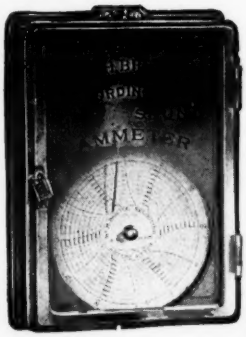

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Recording
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SPEED INDICATORS
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No. 104.—This indicator may be run at the highest speed required without heating. The working parts are encased. Dial has two rows of figures, reading right or left as the shaft may run. Steel pointed spindle with rubber tips for both pointed and centered shafts. The (O) mark may be instantly set at starting point.

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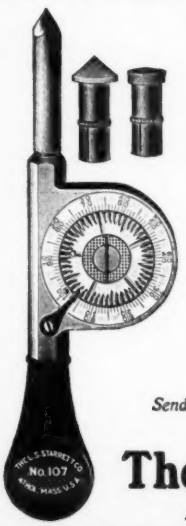

No. 107.—Has all the good points of the above, and in addition has a hard rubber handle for insulation when used on electrical machinery. It also automatically registers the number of revolutions up to 5,000, thus relieving the mind from keeping count.

Price, Postpaid, $3.00

Send for FREE Catalogue, No. 17-R, of Fine Tools.

The L. S. Starrett Co.
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